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WEATHER MODIFICATION RESEARCH

HEARINGS

BEFORE A

SUBCOMMITTEE OF THE

COMMITTEE ON

INTERSTATE AND FOREIGN COMMERCE

HOUSE OF REPRESENTATIVES

EIGHTY-FIFTH CONGRESS

SECOND SESSION

ON

S. 86

AN ACT TO PROVIDE FOR A RESEARCH PROGRAM IN THE FIELD OF WEATHER MODIFICATION TO BE CONDUCTED BY THE NATIONAL SCIENCE FOUNDATION, AND FOR OTHER PURPOSES

MARCH 18 AND 19, 1958

Printed for the use of the Committee on Interstate and Foreign Commerce

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WEATHER MODIFICATION RESEARCH

TUESDAY, MARCH 18, 1958

House of Representatives,
Subcommittee on Health and Science
of the Committee on Interstate and Foreign Commerce,
Washington, D. C.

The subcommittee met, pursuant to notice, at 10 a. m., in room 1334, New House Office Building, Washington, D. C., Hon. George M. Rhodes (acting chairman of the subcommittee) presiding.

Mr. Harris. Let the committee come to order, please.

The committee is meeting this morning to initiate hearings on Senate bill 86 to provide for a research program in the field of weather modification to be conducted by the National Science Foundation.

I might say, as chairman of the committee, that my attention has been called to the importance of this legislation. I have endeavored to schedule the program that it might be considered. I know the sponsors of this legislation have been anxious for hearings now for several weeks. Unfortunately, the members of the committee have been engaged in another matter over the last few weeks. Until we could get our program a little better arranged it has not been possible to start hearings on this and some other legislation.

But some 10 days ago or so I announced to the full membership of the committee that it was my purpose to schedule hearings and asked other members of the committee who are not engaged in the problem of legislative oversight, and so forth, to bear with me and cooperate with us in conducting hearings on this very important legislation.

I considered this, in view of the information that had been brought to me, one of the most important bills that we had pending before us, on which reports have been obtained, and thus are in a position to conduct hearings.

I regret the chairman of the subcommittee, Mr. John Bell Williams, is not here this morning because of illness. He called a few minutes ago or had his office call and consequently I have asked Mr. George Rhodes of Pennsylvania to take over this hearing for us.

I appreciate the members who are here and the others who will be here in a few minutes cooperating in this. I know that with the outstanding witnesses we have on our schedule, we will get the information we need to consider this important legislation.

I am glad to note that we have Senator Case of South Dakota here to express his interest in this legislation. He had told me some time ago how important he considers this legislation. Other people, including some scientists we have talked to, also are here.

I note our colleagues in the House who are sponsors of this bill, Mr. Berry, Mr. Baring, Mr. Dixon, and Mr. Wharton are witnesses. I assume, Mr. Acting Chairman, you will be calling on them first.

Is Dr. Waterman here?

Dr. KLOPSTEG. I am substituting for him. He is not here. My name is Klopsteg, Dr. Paul Klopsteg.

Mr. HARRIS. We have a number of witnesses on our schedule which the chairman will get to as soon as possible.

With that brief statement, I hope my colleagues here will understand it is necessary for me to go to another meeting now as they are waiting there now with some important witnesses from out of the city. I will relinquish the chair to Mr. Rhodes with my thanks.

Senator CASE. Mr. Chairman, would you permit me to express my appreciation of the arrangements you have made: I think everyone here recognizes your responsibilities as chairman of the full committee with the important work you are doing there. No one wants to interfere with that but because of the importance and pressure of that I particularly want to express for the record my appreciation of your being here to open the hearings and the arrangements you have made for these witnesses to be heard.

Mr. HARRIS. Thank you very much. I am very much interested in this program and I want to see the hearings develop this subject fully and completely as I know they will. Two members of the subcommittee are tied up in another meeting, but the other members of this subcommittee I am sure will cooperate to the fullest extent in developing this and considering it so that it can be sent to us in the full committee.

We have before us a report from the Department of Agriculture, which the chairman will have placed in the record, and the reports from the Bureau of the Budget and the Secretary of Commerce, all of which are favorable, which indicates as far as we know there is no opposition to the legislation.

Mr. RHODES. Thank you, Mr. Harris. We are sorry that Chairman Harris cannot stay with us. We know his great interest in this legislation. We also understand his responsibilties in the Legislative Oversight Committee.

The subcommittee is meeting this morning to hold hearings on S. 86. This legislation would provide for an experimental research program in weather modification, to continue and expand a study started in 1954 by the Advisory Committee on Weather Control.

The Advisory Committee on Weather Control was a temporary agency established by act of Congress to study and evaluate various experiments in rainmaking.

The committee set up by Public Law 256, 83d Congress, went out of existence December 31, 1957. In its final report to the President the committee recommended the enactment of S. 86 to set up a program of weather research.

As originally introduced, S. 86 provided for a $5 million 5-year cooperative Federal-State cloud modification research program by the Advisory Committee on Weather Control. Identical bills were introduced in the House. These bills are H. R. 3631 by Congressman Hull, H. R. 5232 by Congressman Berry, H. R. 5954 by Congressman Baring, and H. R. 5958 by Congressman Engle.

Without objection, the text of these bills, identical to S. 86 as introduced, will be inserted in the record at this point as follows:

(The bills follow:)

[H. R. 3631, 85th Cong., 1st sess.]

A BILL To provide for an experimental research program in cloud modification

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, for a period of five years following the effective date of this Act, the Advisory Committee on Weather Control be authorized and directed to formulate a program of experimental research in the field of cloud modification with special reference to areas in the States that have suffered from shortage of natural rainfall.

SEC. 2. The experimental research program authorized by this Act shall be carried on either by contracts between the Advisory Committee on Weather Control and private or public agencies and through cooperative programs with State agencies, including land-grant colleges or other State agencies to be designated by the governor of the State.

SEC. 3. There is hereby authorized to be appropriated a sum not exceeding $5,000,000 for the accomplishment of the program herein authorized: *Provided*, That of the amount appropriated annually during the five years for which this program is authorized, one-fourth shall be available for that part of the program to be accomplished by contract and three-fourths shall be available for the cooperative program to be matched equally by the States.

SEC. 4. This Act may be cited as the "Cloud Modification Research Act of 1957".

(NOTE.—H. R. 5232, H. R. 5954, and H. R. 5958 are identical with H. R. 3631.)

Mr. RHODES. Hearings were held last year by a subcommittee of the Senate Committee on Interstate and Foreign Commerce. After considering the extensive testimony taken in the hearings, the committee amended S. 86 to provide for a research program in weather modification under the National Science Foundation, a permanent operating agency of the Government. Under the revised bill, research would not be restricted to cloud modification, as provided in the original legislation, but would be expanded to embrace other phases of weather modification, including the suppressing or diminishing of hail, lightning, fog, smog, and tornadoes.

The amended bill was passed by the Senate unanimously last August. A companion bill, H. R. 9246, was introduced by Congressman Dixon.

Without objection, the bill as passed by the Senate will be included in the record at this point, together with reports from agencies of the executive branch whose comments were requested by the committee.

(The bill and reports follow:)

[S. 86, 85th Cong., 1st sess.]

AN ACT To provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, The National Science Foundation is authorized and directed to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, or other weather phenomena, and to report annually to the President and the Congress thereon. In conducting such studies, the Foundation shall consult with meteorologists and scientists in private life and with agencies of Government interested in, or affected by, experimental research in the field of weather control. Research programs to carry out the purposes of this Act by the National Science Foundation, and by other Government agencies or departments, may be accomplished through contract with, or grants to, private or public institutions or agencies, including but not limited to cooperative programs with any State through such instrumentalities as may be designated by the governor of such State.

SEC. 2. For the purposes of this Act, the Foundation is authorized to accept as a gift, money, material, or services: *Provided*, That any such gift may, if the donor so specifies, be restricted or limited for use in connection with certain projects or areas. Other agencies of the Government are authorized to loan, without reimbursement, and the Foundation is authorized to receive, such property and personnel as may be deemed useful, with the approval of the Director of the Bureau of the Budget. In addition to the authority contained herein, the National Science Foundation, for the purposes of this Act, may utilize any of the powers granted by the National Science Foundation Act of 1950 (42 U. S. C. 1861–75).

SEC. 3. The Advisory Committee on Weather Control is abolished effective December 31, 1957, and its functions, duties, and records and any unexpended funds are transferred to the National Science Foundation and there is authorized to be appropriated to the National Science Foundation, such amounts as are necessary to carry out the purposes of this Act.

Passed the Senate August 5 (legislative day, July 8), 1957.

Attest:

FELTON M. JOHNSTON, *Secretary.*

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
Washington, D. C., March 17, 1958.

Hon. OREN HARRIS,
Congress of the United States,
House of Representatives, Washington, D. C.

MY DEAR MR. HARRIS: This is in reply to your letter of August 12, 1957, requesting the comments of the National Science Foundation with regard to S. 86, a bill to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

We are familiar with the problems involved not only because of the work of the National Science Foundation in supporting research in the field of meteorology but also through my membership on the Advisory Committee on Weather Control.

From the evaluation activities of the Advisory Committee, evidence to date seems clearly to indicate, except under certain very special conditions of topography, temperature, and other favorable factors, that no large or important rain-producing effects will be achieved by present means without further research to acquire a better understanding of the process by which nature produces precipitation of rain or snow. It is my view, both from the studies of the committee and from consideration given to the subject in the Foundation, that by far the the most important element toward effective progress in weather modification at this time lies in a planned program in support of research by competent scientists on the fundamental problems dealing with the precipitation process. Such studies should be conducted under controlled laboratory conditions and also by carefully planned field experiments. The latter may consist of studies into the conditions under which precipitation occurs naturally and also of studies to determine the factors involved in the effects of man-made attempts to duplicate or augment natural processes. Plans for the latter type of field experiment should include authoritative means for statistical analysis and evaluation, a difficult task.

However, we would like to recommend that a section be added to S. 86 authorizing the National Science Foundation to require by subpena information necessary to carry out its provisions. An example of the kind of language which would be appropriate for this purpose is to be found in section 9 (d) of Public Law 256, 83d Congress, 1st session, establishing the Advisory Committee on Weather Control.

It would seem unwise to attempt to embark upon any program having as its aim the development of a means of weather modification until we have some scientific assurance that such a means is practical and feasible. For these reasons, we advocate enactment of S. 86, which would specifically authorize a systematic research program aimed at securing the answers we need in the general area of weather modification. The National Science Foundation intends to press for further effective research on this general subject. If S. 86 becomes law, the cooperation of other permanent agencies of the Federal Govern-

ment would be actively sought in carrying out such plans for practical developments as might arise out of fundamental research.

The Bureau of the Budget has advised us that it has no objection to the submission of this report.

Sincerely yours,

ALAN T. WATERMAN, *Director.*

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., March 18, 1958.

Hon. OREN HARRIS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D. C.

DEAR MR. HARRIS: This responds to your requests for the views of this Department on S. 86 and H. R. 9246, identical bills to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

We recommend the enactment of either bill.

These proposals would authorize the National Science Foundation to undertake and administer a research program in weather modification. The research program would be executed by making grants to, or contracts with, public or private institutions or agencies, as well as by arranging for cooperative programs with States. Provision is made for consultation with other interested Government agencies, and for the loan and utilization of personnel and property of other Government agencies, with the approval of the Director of the Bureau of the Budget. Annual reports would be required to be made to the President and to the Congress. Section 3 of the bills would abolish, as of December 31, 1957, the Advisory Committee on Weather Control, and transfer its functions, duties, records, and unexpended funds to the National Science Foundation.

In view of the various authorized natural resources programs for which the Department of the Interior is responsible, we have a definite interest in any work which affects water supplies and resources, and we would encourage the undertaking of any reasonable measures which will lead to the alleviation of water shortages, particularly in the arid States of the West, by bringing a supply of water where it is needed when it is needed. For these reasons, we have followed with more than a casual interest the experimental work being conducted in the weather modification field.

It is our opinion that there is now a great need to obtain a better understanding of the basic physical principles involved in the precipitation process. If actual cloud-seeding operations are to be continued, we should know, in the first instance, the mechanism by which natural precipitation occurs and the manner in which cloud nucleation acts. We recognize that at an appropriate time there may be a need for well-controlled, large-scale cloud-seeding experiments to which the basic research data could be applied.

Research of this kind involves long-term programing. For this reason, we favor placing general administrative responsibility in the National Science Foundation, which is devoted to administering various scientific research programs and which has had substantial experience in working with educational institutions and other public and private research organizations.

The Bureau of the Budget has advised that there is no objection to the submission of this report to your committee.

Sincerely yours,

FRED G. AANDAHL,
Assistant Secretary of the Interior.

DEPARTMENT OF AGRICULTURE,
Washington, D. C., March 18, 1958.

Hon. OREN HARRIS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives.

DEAR CONGRESSMAN HARRIS: This is in reply to your requests of August 12 and 16, 1957, for reports on S. 86 and H. R. 9246, identical bills entitled, "To provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes."

The Department of Agriculture has no objection to the enactment of S. 86, as passed by the Senate or H. R. 9246, as introduced in the House.

The bills authorize the National Science Foundation to complete the evaluation work of the Advisory Committee on Weather Control and to undertake an orderly research program in weather modification. The bills would provide for the Foundation to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, or other weather phenomena. In conducting these studies, the Foundation would consult with meteorologists and scientists and with governmental agencies interested in, or affected by, experimental research in the field of weather control.

The availability of water for agricultural use is increasingly urgent, especially in those areas where population growth and growth of industry compete with agriculture for limited supplies. The thousands of forest fires started by lightning storms every year cause substantial damage to the Nation's forest resources. Basic information necessary to develop adequate means of weather modification is lacking. The National Science Foundation could, under the provisions of either bill, undertake the support of the basic research necessary for the development of the needed information.

The Bureau of the Budget advises that there is no objection to the submission of this report.

Sincerely yours,

E. T. BENSON, *Secretary.*

THE SECRETARY OF COMMERCE,
Washington, D. C., March 17, 1958.

Hon. OREN HARRIS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D. C.

DEAR MR. CHAIRMAN: This letter is in reply to your request of August 12, 1957, for the views of this Department with respect to S. 86, an act to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

S. 86 would authorize and direct the National Science Foundation to initiate and support a program of study, research, and evaluation of weather modification, and would abolish the Advisory Committee on Weather Control.

This Department recommends enactment of S. 86.

The Department believes that the extensive experimentation in cloud seeding which has been taken throughout the world has been inconclusive and indefinite. Progress in rainmaking, which potentially has the possibility of developing into a technically sound and respected field of meteorological engineering, has been retarded in recent years by a lack of coordination of the experimental activities carried on by public and private agencies. In addition, a major difficulty has been the limited number of research institutions qualified and equipped to carry out adequate programs of experiments in this field.

We believe that the program envisaged in S. 86, which would center responsibility for the planning and coordination of programs in this area in the National Science Foundation and which would authorize the Foundation to make arrangements for performance of research by qualified private and public institutions, will result in a more expeditious and economical approach to the development of weather-modification techniques. The proposed program would also foster cooperation with private organizations and the States in the development of these meteorological phenomena.

For these reasons, the Department of Commerce recommends enactment of S. 86.

The Bureau of the Budget has advised that it would interpose no objection to the submission of this report to your committee.

Sincerely yours,

SINCLAIR WEEKS,
Secretary of Commerce.

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D. C., March 14, 1958.

HON. OREN HARRIS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D. C.

MY DEAR MR. CHAIRMAN: This is in reply to your letters of August 12 and 16, 1957, requesting the views of this office with respect to S. 86, as it passed the Senate August 6, 1957, and H. R. 9246, identical bills to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

These bills would authorize and direct the National Science Foundation to initiate and support a program of study, research, and evaluation in the field of weather modification.

In the reports that they are making to your committee, the National Science Foundation and the Departments of Commerce, Agriculture, Interior, and Defense are recommending favorable action on S. 86 or H. R. 9246.

Although our view is that the National Science Foundation already possesses the necessary authority to carry out basic research needed to advance the field of weather modification, we would not object to enactment of these bills if the Congress believes that they would give a desirable emphasis to the Foundation's work on this subject.

It should be noted that the language in section 3 of the bills which abolishes the Advisory Committee on Weather Control is unnecessary in view of the passage of the Supplemental Appropriation Act, 1958, which provided that this committee "shall complete its report and terminate its activities by December 31, 1957." These events have taken place. We understand, however, that the National Science Foundation would like to have the bills contain language transferring the records of the committee to the Foundation.

Sincerely yours,

PERCIVAL BRUNDAGE, *Director.*

Mr. RHODES. At this time I would like to call on our first witness, a former colleague of ours in the House, the distinguished Senator from South Dakota, the Honorable Francis H. Case.

STATEMENT OF HON. FRANCIS H. CASE, UNITED STATES SENATOR FROM THE STATE OF SOUTH DAKOTA

Senator CASE. Mr. Chairman and members of the committee, I do appreciate the opportunity you have given me to make a statement with reference to S. 86. I also want to express my appreciation of the interest which several House Members have taken. Congressman Hull, whom you mentioned, came over and appeared at our Senate hearings as did Congressman Berry and I believe Congressman Dixon. Those men have taken a definite interest in this legislation. They made effective statements over there before the Senate committee and it is a pleasure to me to see the interest they have taken and to have Congressman Hull's statement inserted as it has been. I hope he can supplement that with personal testimony as Congressman Berry and the others may be able to do too, before you conclude your hearings.

Mr. Chairman and members of the committee, weather is not an accident. I am not a meteorologist nor scientist, but if there is any single sentence of a few words which could suggest to the committee the basic conviction that I have as a layman who simply has listened and read and been interested, it would be bound up in that sentence. Weather is not an accident. In these days when we are trying to find the rules and the laws which govern the universe and beyond that, space, it seems to me it is important to encourage those programs of

research which will enable us to learn more about the things which produce certain effects and then see how that knowledge can be used for the benefit of mankind. There are, of course, a multitude of variables that create weather but it is not a thing of chance. What are the conditions and the variables that make weather or modify it?

Most of the weather phenomena seem to be conditioned by what happens at high altitudes where you have striking variations in temperature and winds with resulting currents and countercurrents. What man is seeking to do is to find out the recipe that produces weather of different character. The space age opens the door of opportunity to know more about the weather.

I am not a meteorologist, nor am I a scientist. I am merely like millions of other people—one who has learned that weather conditions life. The subject is of challenging and compelling interest in these days when we talk about entering the space age.

Mr. Chairman, the bill before your committee, S. 86, authorizes the National Science Foundation to undertake an orderly research program in weather modification.

In conducting its studies, the National Science Foundation would consult with meteorologists and scientists in private life and with agencies of Government interested in or affected by experimental research in weather control.

The Foundation may accomplish the purposes of this act through contracts with private or public institutions, including cooperative programs with the States.

The National Science Foundation is authorized to accept as a gift, money, material, or services and other agencies of the Government are authorized to loan, without reimbursement, property and personnel as may be deemed useful.

The functions, duties, and records of the Advisory Committee on Weather Control are transferred to the National Science Foundation.

I think in effect that has been done. The Advisory Committee concluded its work as of December 31 and has made its report to the President. I believe the National Science Foundation is already acting as custodian of its records. But Dr. Klopsteg can speak more authoritatively on that.

There is authorized to be appropriated to the Foundation such amounts as are necessary to carry out the purposes of this act.

The possible importance of this bill to the Nation and to the world is tremendous. We spend hundreds of millions of dollars to counteract and alleviate weather-caused disasters; or, I might say, to overcome situations created by a lack of knowledge about the weather or what is coming. It is my earnest conviction that what the Congress does to authorize an orderly experimentation and evaluation program in cloud modification will have lasting significance for conditions of drought, floods, hurricanes, hail, lightning, fog, and smog.

What this would mean for the welfare of agriculture, commerce, industry, and national defense is beyond our power to estimate.

Last November, Dr. Edward Teller, in testifying before the Senate Military Preparedness Subcommittee, said:

> Ultimately, we see again and again that small causes in the weather can lead to very big effects, and when that is the case, prediction becomes very hard. But if we find out precisely where the small causes lie, it may trigger off the bigger effects. If we find out that, we will be on the road to controlling weather on a big scale.

Please imagine a world in which the Russians can control weather in a big scale, where they can change the rainfall over Russia, and that—and here I am talking about a very definite situation—that might very well influence the rainfall in our country in an adverse manner. They will say, "We don't care. We are sorry if we hurt you. We are merely trying to do what we need to do in order to let our people live."

What kind of a world will it be where they have this new kind of control, and we do not? I think as you think—that this and other examples totally become very vivid on your mind—what it might mean to become a second-class power.

Dr. Teller's statement needs no comment from me, but it brought a flood of inquiries to my office as to what was happening with the bill your committee is considering today. At this point I would like to go on record as saying that I would not want the public to anticipate phenomenal results at an early date growing out of anything this bill might produce. I think that perhaps the message that the public ought to have is that we feel that man's knowledge is inadequate in this field, that we ought to get more knowledge, that if we could get knowledge that would improve forecasting, the accuracy of it, and perhaps permit longer range forecasting, that those ends of themselves would be worthy objectives. But the potential that we might even get to the position where by learning these variables we could affect the course of weather, over a large area, as well perhaps as in local areas, is so intriguing that we ought not to place limits upon the research projects that the National Science Foundation would engage in.

Personally I think that the National Science Foundation by the quality and character of its leadership and the men who comprise it is the guaranty to the country that the projects would be worthwhile projects. But by the very nature of research there should not be limitations put in. If we knew what the limitations could be we would not need the research to start with. We ought to have a broad program such as this bill proposes.

Mr. Chairman, I have been interested in water projects of one sort or another ever since I have been in Congress, and long before. I first became interested in cloud seeding back in the late forties when I read about experiments then being conducted.

In my section of the country, our crops always depend on the weather, and in the western part of South Dakota we are always concerned with moisture shortages. In 1950, we were badly in need of rain at our ranch. Crops were parched and the stock dam was drying up. I hired a private pilot to take a hundred pounds of dry ice up and seed a cloud. He got a heavy shower—it missed our ranch by 5 miles—but that the cloud he worked on reacted was beyond doubt. Other clouds that looked the same before he worked on this one did not "fuzz" or "bloom" as this one did, nor did they let go of any rain that afternoon. That rain covered a stretch 5 miles wide and about 15 miles long. I then began to take weather modification in earnest.

The Congress first acted favorably on weather modification legislation in 1953 when it passed the bill that created the Advisory Committee on Weather Control. That legislation, S. 285, Public Law 256, was the outgrowth of bills by Senators Anderson of New Mexico, Cordon of Oregon, Butler of Nebraska, Magnuson of Washington, Smathers of Florida, Lehman of New York, Watkins of Utah, Ecton of Montana, Young of North Dakota, Capper of Kansas, O'Mahoney

of Wyoming, and myself over a period of 3 or 4 years. Three Senate committees held joint hearings on the bills introduced at that time and I was asked to work out a residual bill which was S. 285.

The Advisory Committee on Weather Control was directed to study and evaluate public and private experiments in weather modification. The committee was comprised of the Secretaries, or their designees, of the Departments of Agriculture, Commerce, Defense, Interior and Health, Education, and Welfare, and the Director of the National Science Foundation, or his designee. It also included five private members appointed by the President from the fields of science, agriculture, and business. They were: Capt. Howard T. Orville, United States Navy (retired), Baltimore, Md., the Chairman; A. M. Eberle, dean of agriculture, South Dakota State College, vice chairman; Lewis W. Douglas, Southern Arizona Bank & Trust Co., former Director of the Budget and former Ambassador to Great Britain, Tucson, Ariz.; Joseph W. George, brigadier general, United States Air Force Reserve, Atlanta, Ga.; and Kenneth C. Spengler, executive secretary of the American Meteorological Society, Boston, Mass. The Chairman and Vice Chairman were appointed by the President.

The Advisory Committee was not authorized to conduct basic research in weather modification but was directed to make a complete study and evaluation of the experiments being made by public and private groups for the purpose of determining the extent to which the United States should experiment with, engage in, or regulate weather modification activities.

The life of the Advisory Committee on Weather Control expired on December 31, 1957, and the committee made its final report to the President early this year. For the record, I want to say that that committee did a remarkable job—its report is the most valuable single document in the field, I believe. I hope that members of the committee who develop a special interest in this will avail themselves of the opportunity to get their report and examine it.

That report states that in the mountainous areas in Western United States the seeding of winter-type storm clouds produced an average increase in precipitation of 10 to 15 percent with "heavy odds that this increase was not the result of natural variations in the amount of rainfall."

In nonmountainous areas, the results were not as dramatic but the committee report points out that this does not mean that precipitation may not have been produced. The variability of rainfall patterns in the nonmountainous areas made it difficult to evaluate the changes that may have occurred.

I should like to read one short section from the committee report dealing with its recommendations:

> The committee recommends that a research program include work along the following lines:
>
> (1) The effect of solar disturbances on weather.
>
> (2) The factors which control our global atmospheric circulation.
>
> (3) The factors which govern the genesis and movement of large-scale storms.
>
> (4) The dynamics of cloud motions.
>
> (5) The processes of rain and snow formation, and the relative importance of the physical phenomena which govern these processes.
>
> (6) The electrification process in clouds, and the role electricity plays in meteorological phenomena.

(7) The natural sources of condensation and ice-forming nuclei, and their role.

(8) The methods, materials, and equipment employed in weather modification.

The above recommendations, all of which demand basic and fundamental investigations and research, emphasize the meagerness of our present knowledge. These recommendations also reflect the complexity of the problems that must be investigated to provide the basic scientific knowledge that is essential to a technology of weather control.

Therefore, the committee recommends the enactment of S. 86, 85th Congress, which directs the National Science Foundation to initiate, coordinate, and support such a program.

Mr. Chairman, there is a growing interest in weather modification in this country. Until enactment in 1953 of the Federal law which established the Advisory Committee on Weather Control, only a few States had passed laws in the field of weather modification. By the end of 1956, 14 States, Arizona, California, Colorado, Massachusetts, Nevada, New Hampshire, New Mexico, Oklahoma, Oregon, South Dakota, Utah, Wisconsin, and Wyoming, had provided for regulation of weather modification activities in some degree.

My own State of South Dakota explicitly claims sovereign rights to the moisture in the clouds and atmosphere within our State boundaries. I do not know how they would enforce it exactly but you can see our people at least are alert to the situation. Several States provide for research and experimentation by State authorities.

The United States Forest Service is carrying on a research program known as project Skyfire. The purpose of project Skyfire is to develop more effective means of lightning-fire suppression, including the possibility of preventing lightning fires and reducing fire danger through cloud seeding. Lightning is the greatest single cause of forest fires in Western United States. I might say that the man who directs that program for the Forest Service was in Washington recently. He told me that in 29 missions last summer he felt they had positive results in over 20 of those 29.

Mr. Chairman, there are some scientists present who will explain better than I am able to the experiments that have been made in weather modification and the possibilities that have not yet been explored. I shall leave that responsibility in their hands.

I think the members of this committee will be interested in knowing that after the Senate Committee on Interstate and Foreign Commerce had listened to the evidence presented in its hearings on this bill, every member of the committee who was present asked to be listed as a cosponsor of the bill as it was amended and presented to the Senate, and the bill went to the floor with 16 cosponsoring names on it.

Mr. Chairman, we annually spend millions of dollars for drought relief. We spend millions more for flood relief, and beyond that there are untold millions lost in flood and drought damage.

If clouds could be modified so that rain could be produced in time of drought, or clouds dissipated to prevent disastrous floods, the investment of a comparatively small amount of money would be a wise investment. Even the benefits of more accurate and longer-range forecasting offer tremendous returns for efforts expended even though we did not have the possibility of modifying the weather in any particular.

Water is America's No. 1 problem. Our water use has more than doubled since the turn of the century. Annually we spend millions

of dollars trying to discover new water sources and to better utilize those that we already have, while in the sky there is a reservoir of uncounted billions of gallons of sweet, fresh, clear water. It seems to me that we ought to provide the experimentation program so that this generation and those following can successfully tap that source of supply.

Mr. Chairman, may I conclude by repeating my opening sentence: Weather is not an accident. It conditions all life. Let us learn what we can about it. Thank you, Mr. Chairman.

Mr. RHODES. Thank you very much, Senator Case. We appreciate your very informative statement. Are there any questions?

Mr. O'BRIEN. I join the chairman in congratulating Senator Case on a very fine statement. You developed very fully the fact that we cannot afford not to have this research.

I wonder, do you think it is reasonable to assume that the Russians at the present time are making intensive and extensive studies in this particular field?

Senator CASE. I think it is reasonable to assume they are making studies in the field, but I have no personal knowledge of what they may be doing. I think Dr. Teller's statement rather startled the Preparedness Subcommittee at the time he made it. I was present at the time. Different Senators at the time directed some inquiry to him. Senator Johnson, Senator Smith of Maine, Senator Flanders all commented upon it. But it was an open session, and if Dr. Teller had any specific knowledge he did not disclose it. He did say, of course, what was quoted here. I have no knowledge of it. I think the reasonable assumption or the safe assumption is that with the great emphasis the Russians are placing upon science and upon the things that might improve their agriculture and improve their general situation, they would take steps to learn what they could in this field.

Mr. O'BRIEN. I was startled by your quotation from that testimony, too. I agree 100 percent with you that we must assume that the Russians are doing many things that we have no specific knowledge of and not make the mistake in this field as we have in some others of underestimating their scientific capacity.

Senator CASE. Might I supplement what I said. It is interesting that the Russians should be working in this field because so much of our weather seems to come from the northwest. I know in my area, I am speaking solely from personal experience, in my area the weather we get in southwestern South Dakota one day is somewhat forecast by what is to the northwest of us 18 to 24 hours before that. I believe the prevailing winds and currents of air are such that weather in Alaska or to the west of that moves on to the south and southeast many times.

So that if they should be experimenting or even if they should be learning something about the course of weather, whether you modify it or not, if they are learning something about it, they would have the advantage of forecasting what our weather would be if it is traveling in our direction. To that extent we ought to improve our techniques in getting earlier forecasts as well.

Mr. RHODES. Dr. Neal?

Mr. NEAL. Mr. Chairman, I have no questions. I certainly appreciate the fact that the Senator has presented to us a very, very important and far-reaching problem. Most certainly anything that aids us in determining more about weather conditions, how they can be improved upon, anticipated, more or less controlled, will mean a great deal to this country.

I appreciate the statement you have made. You covered it very well.

Mr. RHODES. I would like to welcome at this time Prof. Charles Raith, with a group of his students from Albright College, Reading, Pa. They are visiting Washington to observe our Government in action, attending committee hearings, sessions of the House and Senate, and touring executive departments. We are pleased to have them with us.

Mr. O'BRIEN. Mr. Chairman, I think one of the great tragedies at this time of the year is to see so many young people come to Washington, watch the 2 Houses in session, and somehow not find the time to go to some of the committee hearings where 90 percent of the laws are really constructed. I think it is a wonderful thing that these young people are here today and I hope many thousands in the next few weeks will find an opportunity to attend committee meetings.

Mr. RHODES. Thank you, Mr. O'Brien.

Mr. DINGELL. I would like to also join with you in welcoming these young people and hope that their visit here will be fruitful. I am sure they can see their very able Congressman, my distinguished friend, Hon. George Rhodes, is presiding over a meeting of a subcommittee of the House Committee on Interstate and Foreign Commerce. I think each of these young people might like to know the jurisdiction of our committee extends over almost everything that moves in this country, when it moves across State lines or affects something which does move across State lines.

Not only are we interested in this committee in railroads and radio and television, pipelines, natural gas, advertising, aviation, but we are also interested in legislation. I think you can see that your very fine Representative, my good friend, Hon. George Rhodes of Pennsylvania, is continuing his interest not only in those things that specifically affect his own district but in matters which affect the country.

I would like to conclude by saying that I hope your visit here will be both enjoyable and educational. I would like to compliment you for having come down here and having expressed your interest in government and hope that if something I may do to make your visit more pleasant comes about, that you will permit me to help your very fine and very distinguished Congressman, George Rhodes, of whom I happen to be very proud. Thank you.

Mr. RHODES. Thank you very much, Mr. Dingell.

Are there further questions?

Mr. LOSER. I would only add this to what has been said by my colleague. It is directed to our visitors this morning from Mr. Rhodes' district. This subcommittee is holding a hearing in an effort to develop a research program in the field of weather modification and our first witness this morning is a very distinguished Member of the United States Senate, Hon. Francis Case from South Dakota. I am happy to have been privileged to hear you explain your bill, Senator. Thank you so much.

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Mr. RHODES. Anything further?

Mr. DINGELL. I want to compliment the very distinguished Senator from South Dakota for his fine presentation this morning and also for the work he did in getting this bill through the Senate. I would like to extend my most warm and cordial welcome to him.

Senator CASE. Thank you very much. I appreciate what all the members of the committee have said in their kind words and their questioning.

I would like to paraphrase what Congressman Dingell has just said. I will appreciate your help in getting it through the House but I also want to thank you for the help which House Members gave us in getting this bill through the Senate. It is the type of legislation which initially does not seem of earth shaking importance. It does not have an immediate crisis ahead of it. But in its total implications I doubt if there is any legislation that will be considered in this session of Congress that has greater potentialities and I certainly appreciate the interest each of the members of the committee has shown by being here this morning and the interest you have taken in your questions and the attentive hearing you have given me.

Mr. RHODES. Thank you very much, Senator Case.

Our next witness will be Congressman E. Y. Berry of South Dakota. Mr. Berry is the sponsor of H. R. 5430.

STATEMENT OF HON. E. Y. BERRY, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF SOUTH DAKOTA

Mr. BERRY. Thank you, Mr. Chairman. I appreciate this opportunity of appearing before this committee. I appreciate the early action of this committee in hearings on S. 86 and on similar House bills among which is my bill, H. R. 5230. I think this is, as Senator Case has said and as members of this subcommittee have indicated, one of the important pieces of legislation that will come before Congress at this session. There has been generated in this country almost a hysterical desire to control outer space, yet the control of the atmosphere is probably many times more important than is outer space. This bill provides a means by which we can develop a control of the atmosphere. The bill provides that basic research be established under the National Science Foundation and it would be my recommendation that a weather commission composed of both scientists and laymen be set up to correlate information already obtained and to move forward under contracts with private industrial groups who have already spent millions of dollars of private money in research; with Government agencies, with State agencies, and with colleges and universities, in the rapid development and research of the various phases of weather modification, of hail suppression, of lightning suppression, of rain and snow increase, and so forth.

I strongly urge that funds appropriated for this purpose be made available through contract, through all of these agencies under the direction of the Commission, responsible to the National Science Foundation who will push forward a weather modification program at the fastest possible rate.

America has already demonstrated what can be accomplished in the race for space when we set our minds and efforts toward that goal.

Let us through this legislation establish the machinery for a similar program to learn how to control the atmosphere which is equally important for both military and economic purposes.

Private enterprise has already spent millions of dollars and has made vast gains in basic research. This bill would provide a coordinating Government agency which is seriously needed. It is long past due, and I trust that this committee will perfect this legislation and report it as early as possible.

I ask unanimous consent at this time to insert in the record the statement of Josiah Ferris, of the American Sugar Cane League of the United States, who is unable to be here and who has mailed to me his statement endorsing, if you please, the testimony that will be given by John S. DiSanto, field director for water resources development, a little later in the hearings.

Mr. RHODES. Thank you, Mr. Berry, for your excellent statement. Without objection, the statement of Mr. Ferris will be inserted in the record.

(The statement of Mr. Josiah Ferris follows:)

STATEMENT OF JOSIAH FERRIS, VICE PRESIDENT, THE AMERICAN SUGAR CANE LEAGUE OF THE UNITED STATES OF AMERICA, INC.

My name is Josiah Ferris. My address is 510 Union Trust Building, Washington, D. C. I am a vice president and manager of the Washington office of the American Sugar Cane League of the United States of America, Inc.

The American Sugar Cane League is a nonprofit corporation domiciled in the State of Louisiana. Its membership consists of more than 7,000 Louisiana sugarcane farmers, who produce approximately 98 percent of the sugarcane grown in the State of Louisiana, and of all of the Louisiana processors of sugarcane into sugar. I appear at this hearing on behalf of that organization and its members.

Sugarcane is the only cash crop on the vast majority of these 7,000 Louisiana farms, and there is no satisfactory cash farm enterprise that can be substituted for sugarcane.

The Louisiana producers of sugarcane and processors of sugarcane into sugar are definitely interested in the ultimate enactment of Senate bill No. 86 which relates to weather modification. Rainfall and moisture is a limiting factor in sugarcane yields in the State of Louisiana practically every year. While it is true the average annual rainfall in the Louisiana sugarcane area is approximately 60 inches, our rains do not usually come throughout the growing season, and each year, with few exception, the growth of the cane is adversely affected by one or more periods with little or no rainfall.

The normal cane growing season in Louisiana is the period from April through October, and the peak growing period is from June through September. During much of the peak growing period, if there is adequate moisture the sugarcane will grow approximately 1 inch each day. In the absence of moisture or adequate moisture, this growth is seriously retarded. Therefore, it is obvious the demand for moisture in the Louisiana sugarcane area during the peak growing period is constant and substantial.

In considering Senate bill 86 in relationship to sugar, it should be borne in mind that sugar, which is produced from sugar cane and sugar beets, is not a surplus crop in the United States. Only 30 percent of the Nation's requirements are produced on the mainland of the United States and only 55 percent of the Nation's requirements are produced in all domestic areas including Hawaii, Puerto Rico, and the Virgin Islands. Approximately 45 percent of our sugar requirements are met by sugar imported from foreign countries.

In view of the facts which I have briefly and generally stated, the American Sugar Cane League and the Louisiana sugar cane farmers and processors are naturally and vitally interested in any properly directed research that might eventually lead to a practical method of obtaining additional rainfall when needed.

We endorse the suggestions made by Mr. John L. DiSanto, field director, Water Resources Development Corp., 460 South Broadway, Denver, Colo., in his testimony on this bill. Those suggestions are:

1. The scope of research should be defined to include basic, applied, and engineering research.
2. The National Science Foundation should be required to establish a Committee on Weather Control composed of 6 scientific members and 5 lay members. None of these committee members shall represent a Government agency or a commercial operator.
3. The various Government agencies concerned with this program shall be designated as technical advisors to the Committee for Weather Control.
4. The commercial operators shall also be designated as technical advisors to the Committee on Weather Control.
5. The Committee on Weather Control shall be responsible for the coordination of all research activities.
6. The bill should provide a method of giving financial assistance to organized groups of farmers, industrial organizations, municipalities and others who have been or are now conducting scientific weather modification activities.
7. The National Science Foundation and its Committee on Weather Control shall be instructed to utilize the knowledge, skill and experience of the private operators in the development and conduct of such research.

We respectfully urge a favorable report of this committee.

Mr. BERRY. I have a number of letters and telegrams from people all over the United States. While I would like to have them made a part of the file, they are too bulky for the record. I would like to ask unanimous consent to read a paragraph or part of a paragraph from these letters, as I identify them.

Mr. RHODES. Very well.

Mr. BERRY. This letter is from William Raabe, chairman of the South Dakota Weather Modification Commission, of Tyndall, S. Dak. Part of his letter is as follows:

If the National Science Foundation receives the funds we should have a joint committee of scientists and laymen to administer the program.

The members of this committee should be nongovernmental people so the program keeps moving.

Both Government agency representatives and private operators may serve as technical assistants.

There is also a letter from Charles Hughes of Denver, Colo., in which he says:

It is inconceivable to me, during a period of national economic concern, that the Government should elect to duplicate and compete with those private corporations and citizens who have the courage and energy to help themselves.

He also encloses a letter to Senator Bible.

From Fairfax, Mo., Pharon Nauman, of Fairfax, says, among other things:

I believe there should be a committee of scientists and laymen to administer this program and have a voice in the control of the funds.

There is a letter from Thomas M. Dines, Colorado Springs, Colo., from which I quote in part:

As a taxpayer I am convinced that our dollars will go further if they are entrusted to those organizations which have had the foresight, the conviction, and the courage to bring this new field of applied science to its present state of being, and in the process have amassed a wealth of background information and know-how which would be most valuable.

There is one from the N. D. Bard Agency, of Stanfield, Oreg., expressing about the same concern and urging passage of S. 86.

There is also a letter from Morrison B. Cunningham, director of public works of the city of Oklahoma City, Okla., urging the same thing.

Truman E. Pease, St. Marys Kraft Corp., St. Marys, Ga., also urges passage of the bill.

I quote from the letter of Vernon Taylor, Jr., Peerless Oil & Gas Co., Denver, Colo.:

> This company has for a number of years used the services of Dr. Irving Krick and have found these services most helpful and have on occasion saved us substantial sums of money.

Roscoe Ozman, Amherst, Colo., encloses a report of the Dallas Water Service.

There is also a letter from Stanley Wallbank, of Denver, Colo.

I have telegrams, received yesterday and today, from several people. James M. Wolf, president of the Cornhusker Weather Modification Association, of Albion, Nebr., urges passage. O. C. Swackhamer, president of the Iowa-Missouri Weather Modification Corp. also sent a telegram in support of S. 86. Walter Myers, executive director of the Forest Farmers Association sent a telegram which reads in part as follows:

> The Forest Farmers Association representing owners of 25 million acres of timberland in 15 Southern States wants to express its continued interest and endorsement of S. 86.

There is a telegram from the committee for Morrow County, Oreg., Weather Research, Inc., endorses S. 86. One from the Sacramento River Weather Association, David J. Elliott, president, Sacramento, Calif., says in part:

> Sacramento River Weather Association, representing 80 bartlett pear growers producing 90 percent of total district tonnage, urge you to support and approve passage of Senate bill 86—

and so forth.

These, I believe, Mr. Chairman, give an idea of the support from all over the United States of people in all walks of life in the passage of S. 86. I thank you.

Mr. RHODES. Thank you, Mr. Berry. The notations will be included in the record.

Are there any questions?

Mr. O'BRIEN. I have had the pleasure of serving on another committee with Mr. Berry for a number of years. His sponsorship of any legislation carries a great deal of weight.

As I understand it, Mr. Berry, this particular legislation would limit the National Science Foundation to study, research, and evaluation and not permit any great project other than a project for study and research and evaluation.

Mr. BERRY. Yes; that is true.

Mr. O'BRIEN. Until we get this information which would flow from these studies and evaluations, Congress could not legislate objectively and constructively in that field. Is that your thinking?

Mr. BERRY. I thought that possibly the bill could be amended to provide that a commission operating under the National Resources Commission, composed of laymen and scientists together, could be established with authority to contract with the existing companies who have been in this business to further promote this program, using their information, making their information available to the Government as well as the Government making their information available to the private companies.

There are several of these companies that have spent vast sums of money in experimental work already. It seems that to get the greatest benefit, the benefit of their knowledge should be made available.

Mr. O'Brien. Would that not be accomplished by this bill as it is now written?

Mr. Berry. It could be, I think.

Mr. O'Brien (reading):

Research programs to carry out the purposes of this act by the National Science Foundation, and by other Government agencies or departments, may be accomplished through contract with, or grants to, private or public institutions or agencies, including but not limited to cooperative programs with any State through such instrumentalities as may be designated by the governor of such State.

Mr. Berry. It could be. The only thing would be to make sure that private companies were included.

Mr. O'Brien. Thank you.

Mr. Rhodes. Are there any further questions?

Thank you very much, Mr. Berry.

Mr. Berry. Thank you.

Mr. Rhodes. Is Congressman Baring here? We are glad to have as our next witness, the Honorable Henry A. Dixon, our colleague in the House, a Representative from Utah, who is sponsor of H. R. 9246.

STATEMENT OF HON. HENRY ALDOUS DIXON, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF UTAH

Mr. Dixon. Mr. Chairman and gentlemen of the committee, first of all I thank you as an old schoolteacher for the welcome you have given these young people. I would like to say as George Bernard Shaw said, "Youth is such a wonderful thing. It is a pity to waste it on the young." I can hardly agree with him when I look into your faces. I think your presence here refutes pretty much the philosophy of that old cynic. As much as I regard him, I certainly do not want to depreciate his great service, I wish that the young people whom I have taught could be closer to this great committee and see what it is doing.

You young people might think that those of us who have introduced bills here about controlling the weather are nuts. I was just talking with 1 or 2 men down here. I said, "Do you think that you have to be nuts to advocate legislation to control the weather?" Mr. Quate over here says, "No, you do not have to be, but it helps."

On February 3, 1958, I met at the White House with a few interested Congressmen and members of the Advisory Committee on Weather Control—and I am pleased to see so many members of the committee here today who were at the formal presentation of their final report to the President. I came away from this meeting more convinced than ever of the urgent need for an expanded, sustained, fundamental research program in weather control. The following are some of my reasons. First, we have definitely made progress in weather control. About 10 years ago 2 scientists, including Nobel prizewinner Dr. Irving Langmuir, succeeded in creating a snowstorm by dropping dry ice pellets from an aircraft into a supercooled cumulus cloud.

For the benefit of these young people, too, I would like to say that sometimes you almost believe in the spiritual control of history. Here we have Senator Case who hired a pilot to go up in an airplane and drop some crystals that brought about a rainstorm. But the rainstorm went on his neighbor's farm rather than on his own. That created an impression and this wonderful Senator now is promoting this legislation. I sometimes think that acts like this are really providential. I certainly praise the great Senator in your presence, young people, for leading out in this cause.

I favor S. 86 or H. R. 9246. First, because we have definitely made progress in weather control as a result of 5 or 6 years of exhaustive research at Mount Washington, N. H., and by General Electric representatives at Schenectady, N. Y. Since then there has been a spate of rainmakers. Some of them made fantastic claims, with little scientific knowledge of weather modification. Since weather control offered promise but had also proved disappointing to many farmers who had paid for cloud seeding, the Advisory Committee on Weather Control was established to study weather modification without preconceived notions. I would like to quote a summary of the findings of this venerable committee. I found in the preface of the volume, volume I of their final report, this summary.

Mr. Chairman, I ask unanimous consent to have this summary of these findings inserted in the record.

Mr. RHODES. Very well. Without objection, they will be included.

(The summary referred to follows:)

A. On the basis of its statistical evaluation of wintertime cloud seeding, using silver iodide as the seeding agent, the committee concluded that:

(1) The statistical procedures employed indicated that the seeding of winter-type storm clouds in mountainous areas in Western United States produced an average increase in precipitation of 10 to 15 percent from seeded storms with heavy odds that this increase was not the result of natural variations in the amount of rainfall.

(2) In nonmountainous areas, the same statistical procedures did not detect any increase in precipitation that could be attributed to cloud seeding. This does not mean that effects may not have been produced. The greater variability of rainfall patterns in nonmountainous areas made the techniques less sensitive for picking up small changes which might have occurred there than when applied to the mountainous regions.

(3) No evidence was found in the evaluation of any project which was intended to increase precipitation that cloud seeding has produced a detectable negative effect on precipitation.

(4) Available hail frequency data were completely inadequate for evaluation purposes and no conclusions as to the effectiveness of hail suppression projects could be reached.

B. On the basis of its physical evaluation, the committee concluded that:

(1) The conventional seeding with silver iodide generators on the ground is a valid technique for producing ice crystals in favorable summer and winter storm situations. (Formation of ice crystals is thought to be essential for the initiation of precipitation from most cold clouds. However, it is relevant to observe that precipitation does not necessarily follow.)

(*a*) Measurements of silver iodide particle concentrations at points several miles distant from the generators were compared with the estimated concentrations there. On the basis of the limited tests made, it was found that the rate of deactivation was low enough to be of no great concern for practical seeding, even during the adverse decay conditions of bright sunlight and warm temperatures.

(*b*) Silver iodide particles in sufficient concentrations to produce seeding effects were found at distances up to 30 miles from the ground generators in particular tests.

(2) Measurements and cloud observations in various regions throughout the United States have indicated that sometimes there is a deficiency of natural ice

forming particles effective at the temperatures at which ice crystals are formed on silver iodide.

We are fortified in the conclusion that significant progress has been made in weather modification by a statement of the American Meteorological Society on April 30, 1957:

1. The seeding of a supercooled cloud with dry ice will usually convert at least a portion of the cloud to ice crystals. Under appropriate conditions, such seeding may release variable amounts of precipitation * * *.

2. The injection of water drops or hydroscopic salt particles into active, warm (nonsupercooled) cumulus clouds may release some rain * * *.

3. In some cases warm fog and stratus may be dissipated in restricted regions by the use of certain hygroscopic materials.

4. At temperatures below about —5° centigrade silver iodide crystals are known to affect supercooled clouds in much the same way as dry ice * * *.

5. Cloud seeding acts only to trigger the release of precipitation from existing clouds * * *.

6. No convincing evidence has been presented which indicates that ground-based silver iodide seeding affects the amount or character of precipitation over flat country. (Mountain country is different.)

7. * * *.

8. * * *.

9. All cloud-seeding operations should be considered as experiments since the techniques are still under development and there is no sound basis for the quantitative estimation of the results in advance of the operation * * *. There is good reason to believe that improved returns from cloud seeding will result from a sound experimental approach and this should be fostered by all concerned.

President Eisenhower has shown personal interest in weather control and on July 18, 1957, he wrote Captain Orville, chairman, Advisory Committee on Weather Control:

Of particular interest was your indication of the probability that, at least along the western coasts, increased precipitation might be expected from cloud-seeding operations. I can readily appreciate the importance such production of additional water supplies might have in helping to ease the Nation's emerging problem of growing scarcity of water resources in many areas.

Mr. Dixon. My second reason for favoring these bills is that droughts incur terrible hardship and should be modified if possible. In Utah we hardly have a spear of grass grow that is not irrigated. Of course, that is not true above six- or seven-thousand-foot level in the mountains, where we have considerable precipitation. We have had terrible droughts there, so extended and long that one of my farm constituents from a Scandinavian country told me, that was 2 years ago, we had not had a normal year of precipitation in 40 years. I do not know where he gets his statistics from, but he really felt what he said.

You can see why I am interested in this weather modification.

One of the deepest impressions of my life has been to visit the 25 counties of my district during the congressional recess, especially during 1955, and see the despair written on the faces of so many of our fine, industrious Utah farmers. This drought, which was probably the greatest in American history, not only produced human misery but was a great economic loss to the Nation. For example, the amount of emergency credit given by the Farmers' Home Administration for the 4½-year period ending December 30, 1957, amounted to $318 million. The emergency feed program, which also operated in serious drought areas, cost $221 million. The hay and roughage program cost an additional $35 million. The Federal Government also spent $184 million to bolster livestock prices during a recent 3-year period primarily required because of the drought.

There was no forage on the winter range. Our farmers had raised very little feed on their farms in the summer and were short of feed for their livestock over the winter. This caused them to push their

livestock onto the market all at once, which depressed the market terrifically. That is why the Government had to support livestock to some extent.

The emergency CAP payments for land damaged by wind erosion primarily due to drought cost $17,956,000. The emergency food distribution programs of the USDA, a significant share of which was for drought, amounted to $156,254,376.

These costs to the taxpayer are only a minute fraction of the billions of dollars of economic loss to the farmers and other citizens of the drought-stricken States. The estimate has been made that nearly 29 million acres of land in the Great Plains States are conditioned to blow away for lack of protective plant cover.

Third, weather control can help reduce other types of damage. Drought is not the only hardship of unstable weather, because enormous damage is also produced by hailstorms, hurricanes, and forest fires caused by lightning. Approximately 70 percent of forest fires, with their costly damage to our timber resources and watersheds, is caused by lightning.

Not long ago I was favored by a visit from Mr. Barrows, of the Forest Service from Idaho, close to McCall out of which place the Forest Service operates the smoke jumping program. I visited these centers, have been out in the primitive area and have watched these boys (the smoke jumpers) jump from airplanes at the risk of their lives to stop fires. I have seen them on fires 25 minutes after the sentinels on the high peaks have given them the alarm.

I know of the cost, the dangers, and the damage of forest fires. Mr. Barrows told me that out of about 29 experiments, 19 or 20 had been definitely positive. What a boon to our timber areas and all of our forests and Federal domain if we can catch clouds before they gather enough to cause electrical storms. Mr. Barrows is quite sure we can stop the source of 70 percent of all of our forest fires. That alone, Mr. Chairman, would justify, in my opinion, many, many times the money that S. 86 and our House bills could call for.

In the fourth place, we need this legislation and appropriation because we must beat Russia to the punch.

H. G. Wells once wrote:

> Human history becomes more and more a race between education and catastrophe.

Dr. Edward Teller, who was quoted by Senator Case, stated that if the present trend continues in 10 years the best scientists in the world will be Russian. This would be a disaster for freedom and human feelings.

America could become as subject to Russia's whims as a rat in a laboratory to an experimenter. If Russia beats us to the punch on learning how to control the natural laws governing weather changes, she could conceivably produce a drought over our whole continent or a disastrous flood. We know that the Russians are devoting great energy and scientific talent to learning how to control the weather. It is urgent that the United States not fall behind in his race.

There are many calls upon Congress for projects to meet the needs of the post-sputnik world. We must evaluate the prospective benefit as well as the cost of each proposal. In the problem of weather control, I believe the stakes are enormous and the cost is relatively minor.

Consequently, this should have high priority in our changing pattern of scientific research. Furthermore, basic research over a long and extended period of time is necessary for purposes of comparison in weather modification. So it is urgent that Congress pass H. R. 9246 or S. 86 to pave the way for a permanent, substantial weather research program conducted by the National Science Foundation in cooperation with other agencies.

Mr. RHODES. Thank you, Mr. Dixon.

Any questions?

Mr. NEAL. Mr. Dixon, inasmuch as the terms and provisions of the Senate measure are practically the same as yours, you have no objection to the adoption of the Senate measure?

Mr. DIXON. None whatever. I should like very much to see our Senator Case get credit for this.

Mr. RHODES. The next witness is our colleague from Missouri, Hon. W. R. Hull, Jr.

STATEMENT OF HON. W. R. HULL, JR., A REPRESENTATIVE IN CONGRESS FROM THE STATE OF MISSOURI

Mr. HULL. I appreciate the opportunity of presenting to the Subcommittee on Health and Science of the Committee on Interstate and Foreign Commerce my views on S. 86 and H. R. 3631, providing generally for a research program in the field of weather modification.

On January 24, 1957, I introduced H. R. 3631 providing that for a period of 5 years following the effective date of the act, the Advisory Committee on Weather Control be authorized and directed to formulate a program of experimental research in the field of cloud modification with special reference to areas that have suffered from shortage of natural rainfall.

The Advisory Committee on Weather Control was established by act of Congress in 1953. It passed out of existence December 31, 1957, and on that date submitted its final report to the President of the United States.

I agree with the various recommendations submitted by the Advisory Committee on Weather Control in its final report, including the recommendations that the National Science Foundation be authorized to initiate and support a program of study, research, and evaluation in the field of weather modification and that S. 86, incorporating authority for this program, be enacted by the Congress.

I ask that my bill, H. R. 3631, be amended to incorporate the language of S. 86 and recommend that this amended bill be passed by the Congress.

Mr. RHODES. Thank you for your testimony, Mr. Hull.

Mr. HULL. Thank you, Mr. Chairman.

Mr. RHODES. The next witness is our colleague from Nevada, Hon. Walter S. Baring.

STATEMENT BY HON. WALTER S. BARING, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEVADA

Mr. BARING. Mr. Chairman, on March 21, 1957, I addressed a letter to the special subcommittee of the Senate Interstate and Foreign Com-

merce Committee on the subject of cloud seeding and weather modification activities conducted in northern Nevada, during the years 1951 through 1956 without Federal assistance. In that letter, I pointed out a need for a scientifically designed and organized program of seeding over a long enough period of time so that the resulting data could be properly evaluated in the interests of both the local participants and the general public. I should like at this time to read that letter to this committee, and to make it a permanent part of the record of these hearings:

"Last month, I received a letter from George G. Moseley, secretary-treasurer, Pershing County Water Conservation District of Nevada, directing my attention to the efforts of Mr. Edmund Muth, Assistant State engineer, and chairman of the Nevada State Cloud Seeding Committee, toward the development of a cloud seeding and weather modification program in northern Nevada.

"Upon receipt of this letter, I immediately established contact with Jack C. Oppenheimer, executive secretary, Advisory Committee on Weather Control. Through him I learned that tests were made in Nevada, under the direction of the Nevada State Cloud Seeding Committee, by the Water Resources Development Corporation of California, and by the North American Weather Consultants, as follows:

"May 1 through July of 1951, in Elko County.

"September 1951 to March 1952, in Elko County.

"December 1, 1954, to June 1, 1955, in White Pine, Lincoln, and Nye Counties.

"November 1, 1955, to May 30, 1956, in drainage area above Owyhee Dam and in the following counties: Humboldt, Pershing, Elko, Lander, and Eureka.

"In addition, John Drackert, formerly manager of Pyramid Lake Guest Ranch in Sutcliffe, Nev., performed several tests.

"These sporadic cloud-seeding operations indicate a need for a scientifically designed and organized program of seeding over a long enough period of time so that the resulting data can be properly evaluated in the interests of both the local participants and the general public.

"The Advisory Committee on Weather Control favors the principles contained in S. 86, introduced by Senator Francis Case of South Dakota, and as they would administer the program, if the bill is enacted, they have expressed an interest in northern Nevada, which is a normal irrigation area, as an area which would provide data of scientific value. Accordingly, I have introduced H. R. 5954 as a companion bill to S. 86, and I feel that the proposed program would definitely benefit Nevada, as well as other Western States."

Under previously appropriated programs, the Advisory Committee on Weather Control established that cloud seeding operations on the western slopes of the Pacific Coast States during the cooler and moist winter and spring months, have increased precipitation some 15 percent over that which would normally be expected. These conclusions are quite significant, but as yet they cannot be applied to other areas. Different climatic and topographical conditions that characterize experimental areas in northern Nevada, and other inland mountain areas, produce certain physical problems that will require additional tests.

I understand that successful cloud seeding requires clouds which extend above the freezing level. The problem is to get the silver

iodide smoke particles from the ground base generators up to these high levels where they will be effective, without the aid of airlifting slopes. Previous tests were successfully accomplished on the western mountain slopes only with this natural assistance. The Advisory Committee, I am also informed, cooperated with the United States Forest Service in a program of research and evaluation in cloud seeding to diminish or suppress lightning. To the extent that this program was successful, the results may be applied to hail suppression operations, since conditions which produce lightning are similar to those which produce hail. A study of tests made in Switzerland indicates that hail frequency has been reduced in those target areas. I have seen extensive destruction caused by hail throughout Nevada.

I do not believe that any weather modification program took place in Nevada during 1957, and even though the law which established the Advisory Committee on Weather Control, which was liquidated on December 31, 1957, provided that all experimental work, either private or Government, be reported to the former Committee for proper evaluation and cataloging, the sporadic cloud-seeding operations heretofore conducted in Nevada have not provided conclusive scientific information. The Pershing County Weather Conservation District of Nevada has requested that northern Nevada, which comprises Pershing, Humboldt, Lander, Eureka, and Elko Counties, be included in such a program as is encompassed in S. 86, as amended, and since the conclusions and tentative observations resulting from western-State tests cannot yet be applied to inland areas without further basic and applied research and experimentation of the kind envisioned by S. 86, as amended. I urge that my bill, H. R. 5954, which has also been amended to conform to the provisions of S. 86, as amended, be reported favorably.

The amendment above referred to would merely transfer from the defunct Advisory Committee on Weather Control to the National Science Foundation, an existing organization, authorization to initiate and support a program of study and research in the field of weather evaluation.

I appreciate the opportunity to appear before this committee.

Thank you.

Mr. RHODES. We appreciate your testimony, Mr. Baring.

Mr. BARING. Thank you, Mr. Chairman.

Mr. RHODES. The next witness is our colleague from Florida, Hon. Paul G. Rogers.

STATEMENT OF HON. PAUL G. ROGERS, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF FLORIDA

Mr. ROGERS. Mr. Chairman, thank you for this opportunity to voice my support of this bill, S. 86.

All sections of the country are vitally effected by the ravages of bad weather, and especially from the effects of drought, flood, hail, and tornadoes. Legislation of this type will add to the understanding of weather, its improved forecast, and eventual modification.

As in the rest of the Nation, Florida people depend on good weather and good weather forecasting. The effects of tropical hurricanes and floods are a constant threat to lives, crops, and industry.

The national hurricane research project, established in 1956 has contributed and continues to contribute much needed information in the field of hurricane development and forecasting. This bill now under consideration, S. 86, will broaden the field of weather investigation and modification, and should be of great benefit not only to farm and industry, but to every man, woman, and child in the country.

In addition to these important factors to the public, the Nation's defense effort will also benefit from this new legislation. Such weather research and modification can be of great help to the defense of this country, and may prove in the future to be absolutely vital in this regard.

The National Science Foundation may be aided under this bill by other Government departments, and with their help conduct experimental research in the field of weather control. Perhaps we are at last reaching the day when someone will actually be able to "do something about the weather." As that day approaches, it is clear that the United States should not be left behind in this field, from the standpoint of national defense.

Every American looks forward to the day when the farmer, industrialist, businessman, and worker might plan his work and play with the weather working for him, instead of against him. In everyday life, improved weather forecasting, and eventual weather modification and control would be a great blessing to all.

This bill, S. 86, will be a big step in the right direction, and establish a sound program for the betterment of all our people.

It is a pleasure to join the many supporters of this legislation and I certainly hope for its speedy adoption by this committee, and the Congress.

Mr. RHODES. Thank you, Mr. Rogers.

Mr. ROGERS. Thank you, Mr. Chairman.

Mr. RHODES. The next witness was to have been Dr. Waterman, Director of the National Science Foundation, but I believe we have a substitute.

Mr. KLOPSTEG. That is right.

I am the Associate Director (Research) of the National Science Foundation and because of Dr. Waterman's unavoidable absence, he asked me to appear in his stead.

Mr. RHODES. Please continue.

STATEMENTS OF DR. PAUL KLOPSTEG, ASSOCIATE DIRECTOR (RESEARCH), NATIONAL SCIENCE FOUNDATION; AND WILLIAM HOFF, GENERAL COUNSEL, NATIONAL SCIENCE FOUNDATION

Mr. KLOPSTEG. Mr. Chairman and members of the committee, I would like to read for the record a statement which Dr. Waterman had prepared for presentation before your committee.

(The statement follows:)

STATEMENT OF ALAN T. WATERMAN, DIRECTOR, NATIONAL SCIENCE FOUNDATION, RE S. 86, A BILL TO PROVIDE FOR RESEARCH IN WEATHER MODIFICATION

Mr. Chairman and members of the committee, I am very happy to set forth my views on S. 86, a bill to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes. This bill calls upon the National Science Foundation to initiate and

support a program of study, research, and evaluation in the field of weather modification. The Foundation would be expected to initiate and support basic scientific research and evaluation programs in the general area of weather modification, particularly through intensified work in the fields of cloud physics and other pertinent areas of meteorology. The bill would also contemplate that, where appropriate and desirable, applied research and development work in weather modification be undertaken.

I am familiar with the problems involved, not only as Director of the National Science Foundation but also from having been a member of the Advisory Committee on Weather Control. From the evaluation activities of the Advisory Committee, evidence to date seems clearly to indicate that no large rain-producing effects will be achieved by present means without further basic research to acquire a much fuller understanding of the processes by which nature produces rain or snow. Ability to modify weather, including control of precipitation, presupposes accurate knowledge of what would happen at a predetermined time if we did not attempt modification. The word "modify" means "change"—changing something that we know in advance would happen naturally. Clearly better understanding is also needed for accurate prediction.

It is my view, both from the studies of the Committee and from consideration given to the subject in the Foundation, that by far the most important element toward effective progress in weather modification at this time lies in a planned program in support of research by competent scientists on the fundamental problems dealing with the precipitation process. In this connection, it is important that the interest of more competent scientists be attracted to careers in meteorological research. At the present time, there are an insufficient number of research scientists in this country working in the field of meteorology. Such studies should be conducted under controlled laboratory conditions and also by carefully planned field experiments. The latter may consist of studies of the conditions under which precipitation occurs naturally and also of studies to determine the factors involved in the results of manmade attempts to duplicate or augment natural processes. Plans for the latter type of field experiment should include authoritative means for statistical analysis and evaluation, a difficult task.

In order to achieve maximum effect in causing or promoting the condensation of water vapor into rain or snow, scientists are generally agreed as to the fundamental requirements to be met since what man can do is almost insignificant compared to the massive scale on which nature operates. The most promising attempt would be to locate some critical point and time where nature's forces are in critical balance and undecided, so to speak, whether to produce rain or not. Then the small nudge which man may make might swing the balance his way. Another general method is to try to devise a chain reaction which will propagate itself and spread rapidly over a large area. This happens in limited fashion in the use of solid carbon dioxide, as discovered by Langmuir. But this is confined, as weather people know, to a particular type of cloud formation and very special conditions of temperature. When these conditions are found, there is not apt to be much moisture present for practical purposes.

The method which has been widely tried over the past few years, the use of silver iodide or similar agents, does not produce a chain reaction but only attempts to provide microscopic particles available for moisture to condense upon and produce ice nuclei. Whether it is successful or not obviously will depend upon whether the condensation at that particular spot requires additional nuclei or not and whether the conditions are such that the condensed moisture will form particles large enough to fall as snow or rain. There is some indication that too much silver iodide inhibits precipitation. We do not yet know the optimum number of nuclei nature needs for precipitation purposes and, therefore, if we provide nature with additional nuclei, do not know whether this will aid or hinder rain formation.

By the above testimony I do not wish to seem unduly pessimistic. Research and experiment to date have shown promise that ultimately we may find a means of weather modification which, hopefully, may be of great practical importance; but evidence to date seems to indicate clearly that generally no large effects will be produced by present means until further basic research has led to great improvement in our understanding of this precipitation process and of the meteorological conditions which may promise more effective results.

For these reasons, I would strongly advocate that at this time a systematic research program be stressed. The problem is one of great difficulty and complexity and should be placed in the hands of only the most competent scientists

and organized teams of scientists. It would seem unwise to attempt to embark upon any program having as its aim the development of means for weather modification until we have some scientific assurance that such means are practical and feasible. It would be even more unwise, in my opinion, to attempt field operations, except as research in appropriate situations, using present techniques in the hope of achieving results of practical importance. Such activities would be misleading, would undoubtedly lead to disappointments and would in all probability involve a waste of money and effort. When one considers that we do not really know whether cloud seeding according to present methods will produce or inhibit rain from many cloud formations, it seems clearly in the public interest not to encourage random or indiscriminate attempts.

I would, therefore, recommend that the legislation or the committee report make it clear that the Congress expects applied research and development work to be undertaken only where the effort holds some promise of success in the light of the knowledge of the underlying phenomena existing at the time.

The provisions of S. 86, while calling upon the Foundation to support an evaluation program, do not provide any authority to secure the necessary information. I, therefore, recommend that S. 86 be amended by adding a section giving the National Science Foundation authority to require by subpena information necessary to carry out the provisions of the act. An example of the provisions which would seem appropriate for this purpose is contained in section 9 (d) of Public Law 256, 83d Congress, 1st session, which established the Advisory Committee on Weather Control.

If S. 86 is enacted, the National Science Foundation intends to press, as a matter of priority, for further effective basic research in the general area of weather modification, particularly in the fields of cloud physics and meteorology. It will carry forward evaluation programs begun by the Advisory Committee on Weather Control, and to the extent that sufficient scientific knowledge is available, initiate and support such applied research or development work as may appear reasonably promising. In undertaking the applied research and development activities, the Foundation would welcome and expect the cooperation of other Government agencies, such as the Departments of Defense, Interior and Agriculture, and the Weather Bureau. It is my understanding that under S. 86 the Foundation could transfer funds to such agencies for these purposes.

With these suggestions I strongly urge enactment of S. 86.

The Bureau of the Budget has advised me it has no objection to the submission of this report.

Mr. KLOPSTEG. May I now say, Mr. Chairman, that I have been Dr. Waterman's alternate, his designee, on the Advisory Committee, and have sat in most of the sessions of that Committee. I have also been and still am a member of the Committee on Meteorology of the National Research Council and both Committees—the Advisory Committee on Weather Control and the Committee on Meteorology—agree on the importance of further research to increase our understanding of the underlying phenomena.

Mr. RHODES. Thank you, Dr. Klopsteg.

Are there any questions?

Mr. NEAL. Dr. Klopsteg, in the past there have been quite extensive studies, particularly by the armed services, in these fields, have there not?

Mr. KLOPSTEG. Yes, sir.

Mr. NEAL. I would presume that were authority given your organization, one of the first things would be to assemble, if that has not already been done, all of the facts that have been brought out that have significance. Your objective in having this bill passed, then, would be to look into the most promising fields of endeavor and to assign further studies in these fields of activity to individuals or groups of individual scientists who you think are capable of going further into the studies. In other words, you would correlate everything that has already been learned and act from there on to discover what potentials there are in the future?

Mr. KLOPSTEG. Mr. Chairman, perhaps I might answer the question by telling you the manner in which the National Science Foundation operates under its act and to indicate the probable procedures for carrying forward its responsibility in this field.

We recognize the fact that in the past the amount of work that has been done in weather control, in weather studies really, or meteorology, in the whole field of atmospheric research has been inadequate as a basis for advancing with great assurance in doing certain things and to accomplish certain modifications. This means that more basic research is required and the Foundation under its act is authorized and directed to encourage and support basic research and education in the sciences. The manner of supporting basic research in the sciences is to seek the advice, through advisory committees, of the most competent people that we can find in a particular branch of science. I think this would be the logical and effective procedure in the field of atmospheric research; namely, to find the most competent people in private life and Government to constitute an Advisory Committee which would guide the undertakings that would then have to be set in operation.

We have a Division of Mathematical, Physical, and Engineering Sciences and we have a Division of Biological and Medical Sciences and we would proceed through the former—as we are already doing—to carry out recommendations of the Advisory Committee and the Committee on Meteorology. We are establishing another section in the Division of Mathematical, Physical, and Engineering Sciences, a section on Atmospheric Research, which would have cognizance of the responsibilities that would be assigned to the Foundation under this act, if passed.

One other point should be mentioned. In our National Science Foundation legislation, as I said before, we are authorized and directed to encourage and support basic research. What S. 86 would add, and an essential addition, is that it would authorize us to support research which is not restricted to basic and fundamental types.

Research would have to be carried on, as our knowledge increases through basic research, in finding ways of applying the knowledge derived from basic research. Obviously, it would make no sense to wait until we knew everything before we started applying it.

In parallel with our efforts in basic research, it should be possible and it is possible under S. 86 to proceed with such applications of knowledge gained through basic research as appear promising in particular areas.

Mr. RHODES. Mr. Dingell?

Mr. DINGELL. Doctor, you referred here to provisions of section 9 (d) of Public Law 256, 83d Congress, 1st session, which established the Advisory Committee on Weather Control.

Would it be possible to lift section 9 and put it into this bill?

Mr. KLOPSTEG. I am not sure and since I have no legal training I would like to ask Mr. Hoff, our General Counsel, to answer that question.

Mr. HOFF. With very few changes.

Mr. DINGELL. Would you submit to this committee a draft of the amendment that you have discussed?

Mr. HOFF. We would be glad to; yes.

(The material referred to follows:)

SEC. —. (a) The Director of the National Science Foundation, or his designee, may, for the purpose of carrying out the provisions of this Act, hold such hearings and sit and act at such times and places and take such testimony as the Foundation shall deem advisable. Any members of the Foundation may administer oaths or affirmations to witnesses appearing before the Foundation or before such member.

(b) (1) The National Science Foundation through the Director, shall be entitled by regulation, subpena, or otherwise, to obtain such information from, require such reports and the keeping of such records by, and make such inspection of the books, records, and other writings, premises or property of, any person as may be necessary or appropriate to carry out the provisions of this Act, but this authority shall not be exercised if adequate and authoritative data are available from any other Federal agency. In case of contumacy by, or refusal to obey a subpena served upon, any person referred to in this subsection, the district court of the United States for any district in which such person is found or resides or transacts business, upon application by the Foundation, shall have jurisidiction to issue an order requiring such person to appear and give testimony or to appear and produce documents, or both; and any failure to obey such order of the court may be punished by such court as a contempt thereof.

(2) The production of a person's books, records, or other documentary evidence shall not be required at any place other than the place where such person usually keeps them, if, prior to the return date specified in the regulations, subpena, or other document issued with respect thereto, such person furnishes the Foundation with a true copy of such books, records, or other documentary evidence (certified by such person under oath to be a true and correct copy) or enters into a stipulation with the Foundation as to the information contained in such books, records, or other documentary evidence. Witnesses shall be paid the same fees and mileage that are paid witnesses in the courts of the United States.

(3) Any person who willfully performs any act prohibited or willfully fails to perform any act required by the above provisions of this subsection, or any rule, regulation, or order thereunder, shall upon conviction be fined not more than $500 for each offense.

(4) Information obtained under this Act which the Foundation deems confidential for purposes of national security or other reasons or with reference to which a request for confidential treatment is made by the person or agency furnishing such information, shall not be published or disclosed unless the Foundation determines that the withholding thereof is contrary to the purposes of this Act, and any member or employee of the Foundation willfully violating this provision shall, upon conviction, be fined not more than $5,000.

Mr. DINGELL. No further questions.

Mr. RHODES. Thank you. I have a number of questions that I would like to have the answers to for the record. If those answers are not available now and if there is no objection on the part of the committee, I would like to have them later.

Mr. KLOPSTEG. Yes, sir.

Mr. RHODES. The last sentence of section 2 provides that in addition to the authority contained in the bill, the Foundation for the purposes of this proposed legislation "may utilize any of the powers granted by the National Science Foundation Act of 1950."

The Foundation, under that act, has a great variety of powers, many of them specifically related to particular things and calculated to achieve particular objectives.

Therefore, is not this particular sentence too vague and indefinite? For example, could the Foundation institute scholarship and fellowship programs for research on weather problems? Is it intended that they shall be able to do so?

Would it not be better to specify the particular powers it is intended that the Foundation shall have?

Mr. KLOPSTEG. I would like to have Mr. Hoff answer that question, Mr. Chairman.

Mr. HOFF. I think in that particular example given we certainly could give fellowships or scholarships under section 10 for basic science in the weather field now. I do not think this would add or detract from what we have. We could enumerate all of the particular clauses, but if you do that, you generally leave out something that is the one thing you want later on.

I would say that no harm would be done by having the general provision and some harm might be done by trying to itemize the particular clauses. I was thinking, in fact, of one thing that should be emphasized and that is that some of the authority in the general act which only relates to basic research should be made specifically applicable to applied research carried on under this act.

Mr. KLOPSTEG. May I add one item?

The Committee on Meteorology of the National Academy of Sciences Research Council recognizes, as I am sure all meteorologists do, the shortage of meteorologists in the United States and therefore this committee has very strongly recommended that steps be taken to increase the number of qualified meteorologists which also can be done under the general authority of the National Science Foundation Act through its fellowship grants.

Mr. RHODES. Mr. Neal?

Mr. NEAL. In other words, your present act gives you that authority?

Mr. KLOPSTEG. That is right, sir.

Mr. RHODES. If all the powers under present law are intended to be available at the discretion of the Foundation, would it not be better to make this proposed legislation a part of the National Science Foundation Act?

Mr. HOFF. I think that could be done just as well and, as a matter of fact, there is a bill introduced in the Senate which has various amendments to our act in it. It could fit in very well with that.

Mr. RHODES. After this bill passed the Senate, the Supplemental Appropriation Act, 1958, became law and it contained a provision requiring the Advisory Committee on Weather Control to terminate its activities by December 31, 1957, and it has actually ceased to operate.

However, section 3 of the bill provides for transferring to the Foundation the functions, duties, and records of the Advisory Committee on Weather Control and provides that the committee is abolished effective December 31, 1957.

Obviously some changes will have to be made in section 3 of the bill, is that correct?

Mr. HOFF. Mr. Rhodes, I have never felt that section 3 did anything as far as we are concerned except to, in effect, make sure that our title to the records was beyond reproach plus, of course, the authorization for appropriations if it is a separate act.

Mr. RHODES. Assuming it is now possible to transfer functions and duties from the Advisory Committee, what functions and duties is it intended to transfer?

The primary functions granted to the Advisory Committee by the 1953 act were those granted by sections 3 and 10 (a); namely, the duty to make studies and evaluations of weather control experiments and to submit reports to the President for submission to the Congress. The

bill already has provisions of a generally comparable nature. Perhaps what section 3 of the bill has reference to are the powers, rather than the functions or duties, which were granted to the Advisory Committee by section 9 of the 1953 act.

If this is so, would it not be much clearer to spell out the powers it is intended that the Foundation shall have? Is this not particularly true in view of the fact that the last provision of section 9 prescribes criminal penalties?

Mr. HOFF. Yes, Mr. Rhodes. Dr. Klopsteg testified that we would recommend including a parallel to section 9 in the bill.

Mr. RHODES. Thank you, gentlemen.

Mr. DINGELL. I have been doing some thinking here about two things. First, what is the amount and the extent of the program that you propose to carry out under this specific piece of legislation, dollar-and-cents-wise? Here we are dealing with a blank check. I would like to know what you folks propose to do with this after we pass this legislation.

Mr. KLOPSTEG. It is a little bit early to prognosticate figures with any degree of confidence, but let me say that as we move into this field more vigorously—we have already been supporting some projects in meteorology as part of our earth-sciences program—we would expect that during the first year of operation for which funds might be asked, we could perhaps usefully apply somewhere near a million dollars. This amount, depending upon the wisdom with which the program is managed and in terms of the advice given us, might grow somewhat during the succeeding years.

The first version of S. 86, as I recall it, provided for $5 million to be authorized for a 5-year program. I think that we can use that as a point of departure to guide our thinking as to the amount involved.

Mr. DINGELL. Would that be an adequate program?

Mr. KLOPSTEG. This will depend, sir, on the number of capable research workers available to carry on the work. Let me add also that probably other funds are going to come into the program if the recommendations of the Committee on Meteorology are carried out. The Committee on Meteorology recognized that of the universities that now have research and graduate work in meteorology, none of them has large and adequate facilities of a type that is needed in field experiments. In order to carry on the research in this vast and complex area of atmospheric research, the Committee recommended the establishment of a National Institute of Atmospheric Research which would be provided with the necessary facilities, such as aircraft that might be required to carry on research, such as radar, such as a device that you might refer to as a rain tower, an enclosure in which laboratory study of precipitation could be carried on, and similar things.

This, in itself, would require a substantial amount of money both for construction and operation and to the extent that basic research were carried on at such an institute, it would, of course, dovetail with, and perhaps also supplement the kind of research envisioned in S. 86.

Mr. DINGELL. May I ask this question: The National Science Foundation assumes all responsibility for translating and watching Russian technical works?

Mr. KLOPSTEG. We have a program of support for translating certain Russian journals.

Mr. DINGELL. Have you any indication of what they are doing in this field today?

Mr. KLOPSTEG. We have nothing directly that has come to us. I believe that possibly the question might well be asked of CIA.

Mr. DINGELL. I understand that they are spending half a billion dollars, but you folks are also spending something.

Mr. KLOPSTEG. We have heard that the Russians have done a great deal of meteorologic research in the Arctic, especially, and they have made many, many landings; between 4 and 5 thousand aircraft landings on some of the large ice islands, for meteorologic studies.

Mr. DINGELL. This is a good bill as far as it goes, but just to take an instance, do you recall Senator Case, who was very active in getting this bill passed in the Senate, mentioned that he had some pilot seeding and the rain same down 5 miles from where he wanted that to come down. I assume that his neighbors wanted that water.

Mr. KLOPSTEG. We hope they did.

Mr. DINGELL. But it is not unlikely that a man could cause precipitation and might create a flood in one area where he did not want it. There are any number of harmful effects. He might be stealing his neighbors' water in effect.

Mr. KLOPSTEG. That is quite correct, and I think Captain Orville could give you an instance mentioned in the early days of the Advisory Committee where there were some wheat growers and cherry growers in adjacent territories. One wanted water and the other did not. To control it there, you would have to be able to control the fall of percipitation at a very narrow zone.

This points up what I think you may have noticed in Dr. Waterman's statement, that before we can control, we must know pretty well in advance what would happen if we did not try to control and then interpose whatever seems proper to bring about the result we desire.

Mr. DINGELL. I was leading up to a very definite point.

This country has been plagued with rainmakers since early days, responsible and irresponsible.

What assurances will we have, or what steps are you going to take, or what legislative measures should we take, to assure knowledge gained by this is not applied recklessly, carelessly, or by ignorant individuals to the great detriment of their fellowmen?

Mr. KLOPSTEG. I am sorry that I did not get the full implication of your question.

Mr. DINGELL. You recall that this country has been plagued with rainmakers since very early days.

What assurance can you give us, or what legislative action should we take, or what administrative action can you take, or would you recommend, to keep the knowledge that is going to be derived from the program, from falling into the hands of ruthless, ignorant, or careless, or reckless individuals?

Mr. KLOPSTEG. The first answer that comes to my mind is that the more knowledge we get, the better it will be all around. So far as motives of people are concerned, I do not know how one can legislate to control them, whether they use the information honestly, or whether they use such information carelessly and principally to their own advantage.

I have no answer except to say that we certainly must watch as we go along to see what happens and to the best of our ability see that only the reasonable and proper things are done.

Mr. DINGELL. You do not have any specific recommendations?

Mr. KLOPSTEG. I have no specific recommendations.

Mr. HOFF. I might add a word or two on that.

In many of the States where there is legislation today, it is of the type of giving notice, prior notice, of weather modification efforts. As far as the Federal Government is concerned, personally, I think it is a little early to recommend any particular legislation. I think that is part of the job of evaluation as more knowledge is gained; it would be part of our responsibility, at the appropriate time, to come back with suggestions as to possible legislation in this field.

Mr. DINGELL. You do feel that there is room for this committee and your branch of the Government to look into the field as the project goes along?

Mr. HOFF. Yes, and as more knowledge is gained.

Mr. KLOPSTEG. The Advisory Committee had that obligation also, to look into the legal situation and its report contains a section on the legal situation which, in part, may answer your question.

Mr. DINGELL. Thank you.

Mr. RHODES. Before you leave, Mr. Klopsteg, could you tell the committee where the records of the Advisory Committee are at the present time?

Mr. KLOPSTEG. It is my understanding, although I have not seen them personally, but I have been told, that we have them now in custody at the National Science Foundation.

Mr. RHODES. Thank you, sir.

Mr. KLOPSTEG. Thank you, sir.

Mr. RHODES. Our next witness will be Dr. Francis W. Reichelderfer of the Weather Bureau, Department of Commerce.

STATEMENT OF DR. FRANCIS W. REICHELDERFER, CHIEF OF THE WEATHER BUREAU, DEPARTMENT OF COMMERCE, WASHINGTON, D. C.

Mr. REICHELDERFER. I do not want to repeat, Mr. Chairman, what has already been said so I will speak from my notes to cover some of the points that may be of interest to you, expressions of views of the Weather Bureau.

Much has been said and written about cloud seeding as a means for augmenting rainfall. After 10 years of experimentation, compromising thousands of individual cloud seeding tests, costing in total many millions of dollars, there is still much uncertainty as to the real possibilities.

As is the case in most problems in science and engineering, the answers will be found only by extensive research. On this point, practically all agencies and individuals that have been active in this field are essentially agreed.

Well-planned and comprehensive basic research in meteoroogy is urgently needed to gain the knowledge necessary, not only for determining what can be done about weather modification, but also for developing the means for better predictions of severe storms, their genesis, movement, and extent.

This urgent need for basic research in meteorology has been emphasized recently by several independent groups, the American Meteorological Society, the Committee on Meteorology of the National Academy of Sciences, the President's Advisory Committee on Weather Control, and others.

References to some of these recommendations are given at the end of this statement.

The Department of Commerce and the Weather Bureau were given opportunity to express their views on the importance of research in relation to weather modification in the hearings of the Senate Subcommittee on Interstate and Foreign Commerce last year. Statements are contained on pages 114 through 131 of the printed record of hearings on S. 86, March 28 and May 13, 1957.

Without repeating the testimony in detail, the following brief remarks sumarize the principal points.

I need not recount the influence of weather and climate on the everyday business activities and personal interests of people everywhere Extremes of weather with their disastrous consequences are always with us, such as droughts or floods, cold waves or prostrating heat, hurricanes and tornados, etc. Man's knowledge of meteorology should be as basic and comprehensive as his knowledge of the sciences of physics and chemistry, for example; yet we know relatively little about the particular processes of condensation of moisture in the free air and its coalescence into snow and rain. There are great gaps in our data of conditions in the atmosphere and many of the basic factors and mechanisms of weather and climate are still unknown or unsolved.

The International Geophysical Year is providing many meteorological observations never before available, but it is only a beginning. The new data will require extensive research. It seems quite obvious that there is pressing need for basic research along the lines visualized in S. 86. We believe this research must be fundamental in nature. Meteorological studies involve some of the most complicated physical and perhaps chemical processes to be found anywhere and they require coordinated research by the most competent scientific staffs experienced in this field. This research does not lend itself to distribution among a large number of research laboratories with little or no experience in meteorological science. Experiences of the last decade have shown quite plainly how easily the inexperienced may be misled in experimenting in cloud seeding. Coordination of the research program under the National Science Foundation as now proposed in S. 86 would provide for well-planned and closely related projects or programs by research organizations well qualified to advance man's knowledge of meteorology and its applications.

One of the first problems to be solved in cloud seeding is how to distinguish between rain that comes entirely from natural causes and rain that is induced artificially. Because of this difficulty, the thousands of tests of cloud seeding in the past have been attended with many uncertainties as to the results. At present the methods of seeding in hope of increasing rainfall are very similar to those used for suppressing cloud development and preventing formation of hail and lightning, and usually the experimental design has not provided definite means for distinguishing between the two processes.

Some experimenters have even held that seeding decreased rainfall. Certainly we have been operating in a field characterized primarily by ignorance of what actually is going on in the clouds.

Strong reasons for basic research in meteorology are also found in the twofold benefits that should be gained. The program should open the way to whatever practical possibilities there may be in cloud seeding and other forms of weather modification and at the same time yield the knowledge on which to build better methods of weather forecasting and incipient storm detection and prediction. Most of the comprehensive basic research programs in meteorology will serve both purposes.

Weather forecasting and storm-warning services have advanced very considerably during the last few years since radar and other improvements in meteorological techniques have become available. Present inadequacies and occasional errors in predictions come primarily from lack of meteorological data and incomplete knowledge of the mechanisms of weather and storms.

In addition to radar, there are other rather recent technological developments that give the basis for greatly increased research in meteorology with good reason to expect successes now where such a comprehensive program a few years ago would have been either impossible or unlikely to succeed. Among these developments are the high speed electronic computer and the earth satellite.

Already the computer is leading the way to improvements in the techniques of weather forecasting. It has also proven itself a powerful means for research in the consequencies of weather control. You are doubtless informed through articles in the press that if the polar icecaps were melted, the resulting rise in sea level would inundate many of the largest cities in the world. Other forms of weather modification would doubtless have consequences that must be understood in advance. For example, one proposal for increasing rainfall in semiarid regions is based on plans for causing more water to be evaporated from the oceans, thus providing more moisture in the air to augment normal precipitation. But we should not forget that humid air is one of the contributing factors to formation of hurricanes and tornadoes. Therefore, it is important to understand the whole process and determine what artificial methods would give beneficial results in weather modification without disastrous consequences. The general circulation studies of the Weather Bureau at Suitland, Md., are leading toward knowledge of this general nature.

Much of the research in which the Bureau is now engaged, including the national hurricane research project in Florida, and the tornado research studies in Kansas City, are closely related to the general program provided under S. 86 and the several projects would be well coordinated so as to supplement one another without duplication.

The Bureau expects to continue the basic and applied research that relates directly to its responsibilities for forecasting the weather and warning of severe storms.

During the last few years, many conferences and evaluation studies have been made of cloud-seeding tests.

They have been reviewed by leading scientists in the field of cloud physics and symposiums have been held in scientific meetings to bring out the conclusions. A 4-day symposium was held at Woods Hole Oceanographic Institute in September 1955 and another at the In-

stitute for Atmosphere Physics, University of Arizona, in April 1956. These and other studies show that meteorologists everywhere are very active in the search for the possibilities of weather modification and its practical applications, but they are seriously handicapped by lack of knowledge in some very vital segments of the science. Much of the experimentation in cloud seeding during the past 10 years has been inconclusive because of the lack of basic knowledge, and many of the unsubstantiated claims which have led people to think these problems already solved, stem from this lack of knowledge. The solution is most likely to be found through the research proposed in this legislation and we endorse it strongly.

It is my understanding, Mr. Chairman, that the amendment to the original bill, S. 86, now incorporated in this bill, providing for coordination under the National Science Foundation, was adopted in order to place this entire, complex program under a disinterested but nevertheless very competent research organization. We believe that this is a very essential part of the plan if it is to be successful.

It is also my understanding that the amendment now included in the present draft of the bill, S. 86, has rather general agreement, not only among the Government agencies concerned, but also among the private agencies and individual representatives who are engaged in cloud seeding.

This concludes what I have to say except for the references to which I alluded at the beginning of my statement, may I present them to the recorder to be included in the record? There are four of them.

Mr. RHODES. Without objection, they will be included.

Mr. REICHELDERFER. Thank you, sir.

(The references referred to are as follows:)

REFERENCES

1. Interim Report to the Council of the American Meteorological Society by the Committee for the Encouragement of Meteorological Research, May 1957.
2. Research and Education in Meteorology—National Academy of Sciences, January 1958.
3. Final Report of the Advisory Committee on Weather Control, Volume I, December 1957.
4. List of Weather Bureau Research Papers, pages 126–129, Senate hearings on S. 86, 1957.

Mr. RHODES. Thank you, Doctor.

Any questions?

We may be having a quorum call any moment. I note that we have a number of distinguished witnesses still to be heard. To avoid coming back, those who wish may make a few brief remarks and file your complete statement in the record.

Mr. NEAL. Doctor, this bill would specifically allocate or set aside, or earmark funds for this particular objective.

May I ask how many of the activities of the National Science Foundation are now being appropriated specifically for certain parts of your work, certain phases of your work?

Mr. REICHELDERFER. Dr. Klopsteg of the Foundation could probably answer that better than I. I can say this, however: There is little, if any, in the regular appropriations to the National Science Foundation that bears directly on the responsibilities of the Weather Bureau as regards forecasting and warning storms. There are 1

or 2 projects in meteorological research in which we have been interested, the Weather Bureau, because of their relation to our responsibility but which we were unable to finance, and the National Science Foundation has provided funds for these studies to be carried on at the universities concerned.

Mr. NEAL. Do I understand you correctly, when I asked you if practically all of the activities engaged in by your organization are carried on by funds appropriated specifically for some particular phase of your activity, or do you get your appropriation in one lump sum?

Mr. REICHELDERFER. The Weather Bureau gets its primarily in one lump sum for salaries and expenses, under that general heading.

Mr. NEAL. If you were not to have this particular measure passed, you would go before the Appropriations Committee next year and ask for an increase in funds for this particular phase of the work? Would that be the same advantage to you that you have had in the past?

Mr. REICELDERFER. We have asked in the past almost each year for additional funds for research along this line to be appropriated, not for the total research program—not for the program that visualizes as comprehensive research as is contained in S. 86, but rather for projects that deal directly with weather forecasting, weather reporting, and storm warnings. Perhaps I have not answered that clearly.

Mr. NEAL. The reason I asked that is, do we by periodic legislation appropriate funds for projects as they come up and thereby perhaps complicate the whole system of appropriations? I wondered if it could be possible for the National Science Foundation to apply to the Appropriations Committee annually, particularly specifying the various activities they want and justify appropriations for that amount and make it a good bit simpler than the present method of legislating from time to time, piecemeal, the type of thing that we do.

Mr. REICHELDERFER. Certainly it is my understanding that one of the purposes of the bill is to bring all of this related weather modification research together.

Mr. NEAL. In this particular line of the National Science Foundation's activities?

Mr. REICHELDERFER. That is my understanding, yes.

Mr. NEAL. I think there is no doubt but what this appropriation is justified. I do not think there is any question but what the bill is justified.

The reason I ask you that question is to try to make it more comprehensive to the people who sit on the Appropriations Committee to know that your science foundations are doing certain types of work, that you apply to them, and you specify and delineate the type of things you are going to do and the amount of money needed, and ask for an appropriation in a single sum to carry that on.

Would it not be simpler legislation for it to be done that way?

Mr. REICHELDERFER. It seems to me that a coordinated plan is certainly better for a program of this kind, a comprehensive program.

On the other hand, the Weather Bureau has funds for hurricane research as such. I think this is so closely related to our responsibilities for storm warings that there——

Mr. NEAL. Pardon me, but that Bureau is not administered through your organization?

Mr. REICHELDERFER. I represent the Weather Bureau. I do not represent the National Science Foundation.

Mr. NEAL. You do not represent the National Science Foundation?

Mr. REICHELDERFER. I do not.

Mr. NEAL. Yours is a separate institution, separate item?

Mr. REICHELDERFER. That is correct.

Mr. NEAL. Thank you, sir.

Mr. RHODES. Thank you, Dr. Reichelderfer.

We will meet again tomorrow morning at 10 o'clock. Those of you who have come any distance and want to get away, can file your statements for inclusion in the record.

We have Dean A. M. Eberle, formerly vice chairman of the advisory committee on weather control of South Dakota State College.

Would you care to come back in the morning?

Mr. EBERLE. Yes, Mr. Chairman. I will come back in the morning.

Mr. RHODES. Who cannot come back tomorrow? Who would like to make a brief statement now before we adjourn?

Mr. LANGFITT. I do not have any oral statement to make except that we have had a controlled project in our area and I would like to comment on that, if anyone would desire any information about it.

I have a written statement that I would like to file.

Mr. RHODES. Without objection, it will be filed.

(The statement referred to follows:)

STATEMENT OF MERRILL J. LANGFITT, FARM SERVICE DIRECTOR, KMA, SHENANDOAH, IOWA

Mr. Chairman and members of the committee, it is a pleasure to appear before this committee for the purpose of expressing my views relative to legislation for studies of and research in weather modification and in addition, all applications of weather.

I would like to first preface my remarks by saying that I am farm service director for radio station KMA at Shenandoah, Iowa. We are a regional, 5,000-watt station, serving the heart of the Corn Belt and have been in operation as the farmers' radio station for 33 years. In view of the importance of weather to farmers and the critical importance of weather to farm income, we are vitally interested in weather and all its ramifications. I spearheaded the organization of an 8-county weather modification program which has been in operation for 2 successive years. Prior to 1956 I did some experimental cloud seeding with dry ice in the southwest Iowa area.

In view of the fact that so little seems to be known about weather modification, at least as an exact science, it seems appropriate that we must not waste more time in carrying out research in this field with the thought in mind of finding answers. We in the Corn Belt are much more interested in knowledge and facts on the subject than we are in theories that weather modification is or is not practical. The President's Advisory Committee has reported that weather modification is now a proven science, but that where and when it is most effective is not conclusively answered to this date. In consideration of the work that has already been done, it seems logical to proceed from here and go forward with some progressive research to prove the unknown factors.

I frankly have not been completely satisfied with the progress the United States Weather Bureau has made in this field. I don't feel they have reached out as far as they could or should in the field of weather research. Much too little has been done in weather research as it relates to agriculture. If Russia continues to advance in science as she has already shown she is capable of doing, we in this hemisphere cannot afford to continue to be slowed down by jealousies, technicalities, and continual bickering among the private and public agencies capable of advancing the science of weather modification. I commend the Weather Bureau for the forecasting services they now render, but at the same time I want to be on record to the effect that present forecasting procedures are not adequate. Longer-range forecasts must be developed and surely this

can only come through more knowledge of weather phenomenon. I want to say that I am not trying to pose as an authority on the subject, but for the record, I do have a bachelor of science degree from Iowa State College. The fact is, we have very few authorities in this country in the field I am discussing. I'm sure we need more of them—and fast.

Weather is important militarily, but likewise it is important in the field of food production. It is the latter field in which I am primarily interested. When we have moisture we produce food. Conversely, when we have drouth, we do not produce food.

My proposals are these:

1. We must not lose any of the research that has already been done by the Weather Bureau, private operators, power companies, farmers, or anyone else who has studied the subject.

2. We must make sure that no individual or no group, Government bureau or otherwise, shall have complete control of future research.

3. We must have a factfinding body, properly decentralized and properly constituted, removed from prejudices and complacencies, with the brainpower and initiative to move forward, responsibile only to Congress.

4. We must have adequate funds for such a committee to progress the science so that America can be the leader in a worldwide competition to control weather.

5. We must have funds above and beyond committee requirements so that properly organized lay groups can lend some assistance to research.

6. We must have funds so that professional groups can be assisted to the point of contributing to the total effort (college and univerity people, etc.).

7. We must inform the public of progress being made in an effort to eliminate any prejudices or fears individuals may have.

8. We must continue to apply our knowledge on practical projects in an effort to prove or disprove research conclusions and improve techniques.

9. We must keep our private-enterprise system foremost in mind and give those groups an opportunity to contribute their knowledge to the field of weather research.

10. It appears that speed of action to facilitate new and additional weather research is of the greatest importance.

Now I am convinced, after 2 years' experience in a controlled area, that some weather modification can be achieved. I am, by no means, convinced that we can turn precipitation on or off as we may desire. At the same time, I feel confident that such is within the realm of possibility. On the subject of research, if the day were here when farmers could have an accurate long-range forecast for a year in advance, much of the gamble could be eliminated from farming. I feel that we are on the brink of such achievement, but the break-through has not been accomplished to this date. Without any governmental assistance we might achieve an accurate 12-month, long-range forecast in 5 to 10 years. With some immediate help, it seems inevitable that we could be there in 2 years or less.

It seems to me that people in authority are going to have to make up their minds whether we are going to stand still in the field of weather modification and control, or whether we are going to go some place fast. Our very way of life is greatly dependent on the weather. He who first achieves weather control may easily write the history of man's future years on earth. The stakes are too high for us to fail in this endeavor. The development of all of the last sciences of food production could very well be dwarfed by the development of perfecting the science of weather in all of its phases.

Mr. DINGELL. Would you please give us your full name and tell us whom you represent?

Mr. LANGFITT. My name is Merrill J. Langfitt and I am the farm service director of radio station KMA, Shenandoah, Iowa.

Mr. RHODES. Is there anyone else?

Mr. ORVILLE. My name is Capt. Howard T. Orville, former Chairman of the Advisory Committee on Weather Control. I will be able to come back tomorrow morning.

Mr. RHODES. Is there anyone else who cannot come back tomorrow and wishes to file a statement now?

If not, the meeting will be adjourned.

(Thereupon, the hearing was adjourned at 12:05 p. m.)

WEATHER MODIFICATION RESEARCH

WEDNESDAY, MARCH 19, 1958

House of Representatives,
Subcommittee on Health and Science,
of the Committee on Interstate and Foreign Commerce,
Washington, D. C.

The subcommittee met, pursuant to recess, at 10 a. m., in room 1334, New House Office Building, Hon. George M. Rhodes (acting chairman of the subcommittee) presiding.

Mr. Rhodes. The committee will please come to order.

STATEMENT OF HON. GEORGE S. McGOVERN, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF SOUTH DAKOTA

Mr. Rhodes. The subcommittee is meeting this morning to resume the hearings on S. 86 and related bills, to establish a program for research in weather modification.

We are privileged to have as our first witness one of our distinguished colleagues, the Honorable George S. McGovern, of South Dakota.

Mr. McGovern. Mr. Chairman and members of the committee, I appreciate this opportunity to make a brief, informal statement today in support of this bill with some modifications in the bill as it is now written.

I might say that I am not a sponsor of the legislation under consideration, but two of my South Dakota colleagues are, Congressman Berry from the Second District of South Dakota and Senator Case, and I certainly want to join in their efforts in support of this legislation along with the other sponsors of the bill.

Now I know that there are several people in the hearing room here today who are nationally known and internationally known experts in this field, some of whom come from my own State, Mr. Di Santo and Dean Eberle of South Dakota State College. I certainly don't want to infringe on their time. I could not help but think, as I looked out the window here a few minutes ago, that these people are very efficient; they have already brought on rain after arriving here in Washington only a couple of days ago. I think that speaks very well for their effectiveness. We may not need rain here in Washington, but there are a great many parts of the country where we do.

I think this is a field of legislation that is very vital to the Congress and to the whole country.

Just the other day I was reading an authentic report which came from the Soviet Union, pointing up the efforts that they are undertaking in this field.

I do not like to think that we have to wait for a challenge from behind the Iron Curtain before we begin to move on an important legislative matter, but sometimes it does help to keep our eye on what our competition is doing. Certainly they are making very definite strides in this field, recognizing the close relationship between food production and their strength in the cold war struggle in which we will probably be engaged for many years to come.

There is no asset that we have here in the United States that is any more fundamental, in terms of our own strength, in our struggle to preserve our way of life than our food production.

I think sometimes we underestimate the tremendous factor that food production is in our total national strength. You may remember during both World War I and World War II that we developed a slogan, "Food Will Win the War." I think in a very real sense that was more than a slogan; that our ability to feed our own armies and our own civilian population and to take care of some of the food needs of our allies was a very important factor in our success in both of those two great contests.

But even in times of peace, food is of tremendous importance to our national strength and in terms of our ability to meet our commitments all over the world. Toward that end, as a representative from a farm State, I am very much interested in any research proposal, or any kind of a proposal, that might strengthen our ability to produce food or to produce it on a more secure basis, so that we can eliminate some of the hazards that are involved in this very important matter of producing food for our own tables and for the tables of the world.

I want to urge the committee and the Congress to give very serious consideration and to take action as soon as possible on this proposal to accelerate research and development in the field of weather modification.

There are just two suggestions that I would like to make to the committee, and I know that there are people here who are qualified technically to outline the reasons for these suggestions.

First of all, I am convinced that any kind of research in this field ought to include applied research as well as basic research.

It doesn't accomplish very much to confine research to pure theory if we cannot experiment and apply some of that research in a practical manner.

I think the bill ought to make very clear that any funds which the Congress sets aside for research on weather modification ought to be available, not only in the field of basic research but in applied research.

The second suggestion that I would make is very closely related to the first one and that is that support for such research ought to be available to private institutions as well as to Federal and State institutions. Some of the finest work, in fact most of the really excellent work that has been done in this field, has been carried on by private institutions and if funds are to be made available to carry on such research in the future, by the Congress, it ought to be made available to the private foundations and private groups, as well as to State and Federal agencies.

As a matter of fact, one of the Federal agencies that might be involved in this bill has actually ridiculed the whole matter of weather modification. This does not necessarily mean that the program is bad

because it is ridiculed, because it has not been long since people were ridiculing the idea that we could launch a satellite, or, someday launch a rocket that might reach the moon. Ridicule itself has no bearing on the program, but it seems to me it would be ill advised to place the control, particularly of the application of the research in this field, in the hands of an agency that for years has been ridiculing developments in this field.

This would be a perfect example of putting the fox in charge of the chicken coop. Certainly if we are going to see any success in the program it must be handled by people who are sympathetic to it and who have some vision and courage and imagination in exploring all the possibilities in this very important field.

Mr. Chairman, that is about all I have to suggest to the committee and I thank you again for the opportunity to appear here.

Mr. RHODES. Thank you very much for your statement, Mr. McGovern.

Any questions?

Mr. LOSER. I would just like to say this to my distinguished colleague—that he has made a magnificent statement about this bill and I want to very heartily commend him for it.

Mr. MCGOVERN. I appreciate that, Mr. Loser.

Mr. NEAL. I am sorry I didn't get to hear your complete statement. I want to discuss whether research should not be basic and practical, as well, and I wonder if we might go far enough to draw the line between the point where information through basic research becomes available to the public and to industry. Where would you draw the line between the appropriation of Federal funds for basic and practical research?

In other words, shouldn't the Government, after basic research becomes available to industry, cease to become financially responsible for practical research? That is my point.

Mr. MCGOVERN. I do not know whether I fully understand your question, Mr. Neal, but I do not want to give the impression that I am opposed to funds being used for basic research, but as the bill is now drafted, placing the program in the hands of the National Science Foundation, which is authorized to carry on only basic research, it seems to play down the use of such funds for the practical application of research findings, and all I am saying is I think the bill ought to make it perfectly clear that some of this money should be available for applied research.

Mr. NEAL. That is the very point I am trying to bring out. When you extend Federal funds beyond the point of furnishing basic research information to individuals and corporations and groups, then you are getting into a very far-reaching potential insofar as Government operations in industry or anything else is concerned.

My thought is there should be a line of demarcation as to how far these funds might be used in any of these projects, whether it is basic research in weather or what not.

When the Federal Government appropriates money and encourages and allocates funds for basic research and makes that basic research information available to industry and industry people who might be inclined to go along and develop these things, it would seem to me that that is as far as the Government should go.

Mr. McGovern. Well, that, of course, is a matter of personal opinion, Mr. Neal, and I respect your view on it, but it just seems to me that we would be limiting the effectiveness of the money that we allocate to this program if we limited it purely to basic research. I think we will get more for the dollars spent if we do not limit it in that fashion.

Mr. Neal. That is a matter of personal opinion.

Mr. McGovern. Yes.

Mr. Neal. Thank you.

STATEMENT OF HOWARD T. ORVILLE, TECHNICAL CONSULTANT, FRIES INSTRUMENT DIVISION, BENDIX AVIATION CORP., BALTIMORE, MD.

Mr. Rhodes. Our next witness is Howard T. Orville, captain, United State Navy (retired), formerly chairman of the Advisory Committee on Weather Control, and now technical consultant, Fries Instrument Division, Bendix Aviation Corp., Baltimore, Md.

Mr. Orville. Mr. Chairman, I have a short prepared statement here, which is an impartial statement based on some 235,000 miles of travel with the various task forces with the Advisory Committee on about 48 different trips in which there was anywhere from 2 to 4 members of the Advisory Committee that made these field trips into the high Sierras, out into the Dakotas and the drought area at that time and made personal observations of the cloud seeding operations in those States; so that the final report, which was sent to each Member of Congress, and my statement here, which is a very brief one, outlines the results of those findings covering a period of about 4 years.

Mr. Chairman, if I may, I would like to read this statement into the record.

Mr. Rhodes. Proceed.

Mr. Bush. Before you do that, Mr. Orville, you were a member of the Advisory Committee?

Mr. Orville. I am past Chairman of the Advisory Committee on Weather Control. This was a temporary committee.

Mr. Bush. The Advisory Committee was set up to advise the National Finance Committee?

Mr. Orville. No. It was set up, the Advisory Committee on Weather Control was set up to make a study and evaluation of all weather observations, both public and private, and to determine what the United States policy should be. This was a committee established by law in August 1953, and it was an 11-man committee, 5 members from private life who have qualifications in business, agriculture, and science, and 6 members from Government departments including Dr. Waterman, the Director of the National Science Foundation. That made up the Advisory Committee on Weather Control which was disestablished on December 31, 1957, when the Committee submitted its final report to President Eisenhower and went out of business.

Now if I may read my statement, Mr. Chairman?

Mr. Rhodes. Proceed.

Mr. Orville. This is the statement of Howard T. Orville, vice president, Beckman & Whitley, Inc., and past Chairman Advisory

Committee on Weather Control, before the Subcommittee on Health and Science of the House Committee on Interstate and Foreign Commerce.

Mr. Chairman and members of the committee, it is my pleasure to appear before you today to set forth my personal views in favor of S. 86, a bill to provide for research in weather modification. This bill, as I understand it, would direct the National Science Foundation to initiate and support a program of study, research, and evaluation in the field of weather modification, and to report annually to the President and the Congress thereon.

Before its disestablishment on December 31, 1957, the Advisory Committee on Weather Control had unanimously recommended the enactment of this bill into law. The need for such legislation has been cited in several instances in the final report.

Your attention is respectfully invited to the summary of findings, recommendations, and recommendations for general meteorological research, contained on pages vi, vii, and viii of volume I of the final report of the Advisory Committee on Weather Control, and I have a copy of this volume with those references, if you care to have them inserted in the record.

Mr. RHODES. Without objection, it will be done.

(The material referred to follows:)

SUMMARY OF FINDINGS

A. On the basis of its statistical evaluation of wintertime cloud seeding using silver iodide as the seeding agent, the committee concluded that:

(1) The statistical procedures employed indicated that the seeding of winter-type storm clouds in mountainous areas in Western United States produced an average increase in precipitation of 10 to 15 percent from seeded storms with heavy odds that this increase was not the result of natural variations in the amount of rainfall.

(2) In the nonmountainous areas, the same statistical procedures did not detect any increase in precipitation that could be attributed to cloud seeding. This does not mean that effects may not have been produced. The greater variability of rainfall patterns in nonmountainous areas made the techniques less sensitive for picking up small changes which might have occurred there than when applied to the mountainous regions.

(3) No evidence was found in the evaluation of any project which was intended to increase precipitation that cloud seeding had produced a detectable negative effect on precipitation.

(4) Available hail-frequency data were completely inadequate for evaluation purposes and no conclusions as to the effectiveness of hail-suppression projects could be reached.

B. On the basis of its physical evaluations, the committee concluded that:

(1) The conventional seeding with silver iodide generators on the ground is a valid technique for producing ice crystals in favorable summer and winter storm situations. (Formation of ice crystals is thought to be essential for the initiation of precipitation from most cold clouds. However, it is relevant to observe that precipitation does not necessarily follow.)

(*a*) Measurements of silver iodide particle concentrations at points several miles distant from the generators were compared with the estimated concentrations there. On the basis of the limited tests made, it was found that the rate of deactivation was low enough to be of no great concern for practical seeding, even during the "adverse" decay conditions of bright sunlight and warm temperatures.

(*b*) Silver iodide particles in sufficient concentrations to produce seeding effects were found at distances up to 30 miles from the ground generators in particular tests.

(2) Measurements and cloud observations in various regions throughout the United States have indicated that sometimes there is a deficiency of natural

ice-forming particles effective at the temperatures at which ice crystals are formed on silver iodide.

RECOMMENDATIONS

The development of weather modification must rest on a foundation of fundamental knowledge that can be obtained only through scientific research into all the physical and chemical processes in the atmosphere. The Committee recommends the following:

(1) That encouragement be given for the widest possible competent research in meteorology and related fields. Such research should be undertaken by Government agencies, universities, industries, and other organizations.

(2) That the Government sponsor meteorological research more vigorously than at present. Adequate support is particularly needed to maintain continuity and reasonable stability for long-term projects.

(3) That the administration of Government-sponsored research provide freedom and latitude for choosing methods and goals. Emphasis should be put on sponsoring talented men as well as their specific projects.

(4) That an agency be designated to promote and support research in the needed fields, and to coordinate research projects. It should also constitute a central point for the assembly, evaluation, and dissemination of information. This agency should be the National Science Foundation.

(5) That whenever a research project has the endorsement of the National Science Foundation and requires facilities to achieve its purpose, the agency having jurisdiction over such facilities should provide them.

RECOMMENDATIONS FOR GENERAL METEOROLOGICAL RESEARCH

The Committee recommends that a research program include work along the following lines:

(1) The effect of solar disturbances on weather.

(2) The factors which control our global atmospheric circulation.

(3) The factors which govern the genesis and movement of large-scale storms.

(4) The dynamics of cloud motions.

(5) The processes of rain and snow formation, and the relative importance of the physical phenomena which govern these processes.

(6) The electrification process in clouds, and the role electricity plays in meteorological phenomena.

(7) The natural sources of condensation and ice-forming nuclei, and their role.

(8) The methods, materials, and equipment employed in weather modification.

Essential to the foregoing program is the development in large numbers of highly qualified research scientists in this field, a point brought out elsewhere in this report.

The above recommendations, all of which demand basic and fundamental investigation and research, emphasize the meagerness of our present knowledge. These recommendations also reflect the complexity of the problems that must be investigated to provide the basic scientific knowledge that is essential to a technology of weather control.

Therefore, the committee recommends the enactment of S. 86, 85th Congress, which directs the National Science Foundation to initiate, coordinate, and support such a program.

Mr. ORVILLE. It is my opinion that a continued and stable research program in weather modification should be established at the earliest practicable date. It is believed that S. 86 should provide for funds being authorized to the National Science Foundation for periods up to 5 years. These allocations should be available in any desired amount annually, during this period.

Experience has shown repeated failures in achieving desired results because of the uncertainty of annual allocations of funds. I would therefore recommend a provision which would permit the National Science Foundation to request and receive funds through normal budgetary channels for designated research programs which are expected to be active for a period up to 5 years.

It is my personal opinion that a greatly extended research program should be started at the earliest practicable date. This program should be carefully developed and guided by scientists of the highest competence in their respective fields. These scientists should have such qualifications in chemistry, physics, mathematics, atmospheric electricity, climatology, meteorology, and other fields that might assist in the development of a well rounded research program. This program should include projects in 10 to 12 areas in the United States in order to permit a study of all climatic conditions where one or more atmospheric processes may be operating, alone or in combination, to cause the weather phenomena which are experienced in each area.

It is my personal observation that there has been too much complacency in establishing an appropriate research program in weather modification. In its final report, the Advisory Committee on Weather Control has repeatedly emphasized the meagerness of our knowledge of the physical and chemical processes in the atmosphere.

Your attention is respectfully invited to statements contained in the final report, one by Dr. Vannevar Bush, now chairman of the Corporation of the Massachusetts Institute of Technology, and Prof. Henry G. Houghton, chairman of the Department of Meteorology of the Massachusetts Institute of Technology.

Similar statements have been made by Senator Lyndon B. Johnson, chairman of the Military Preparedness Committee, and Dr. Edward Teller of the University of California. Copies of these latter statements are available for the record if you desire them.

All statements emphasize the need and urgency of establishing a greatly accelerated and expanded research program on a carefully controlled basis. It is not believed that any of them would desire a "crash program," nor would I so recommend.

In view of the above comments it is my opinion that the priority assigned research in weather modification should be the same as that for guided missiles and satellite development.

In the light of events since October 1957, it would appear that the Defense Department and the State Department should again carefully review current research programs presently underway in weather modification.

The recommendations given by the Advisory Committee on Weather Control in volume I of its full report reflect the complexity of the problems which must be investigated to provide the best scientific knowledge that is essential to the technology of weather control. For this reason it seems appropriate that a careful review of the military and propaganda implications be carefully reviewed by these departments.

With reference to S. 86 the following comments or suggested changes are submitted for consideration:

(*a*) Page 2, line 19, insert the word "hurricanes" between the words "experienced" and "floods."

The reason for that recommended change is because there has been discussion of eventual attempts to modify hurricanes. Of course that would probably be in the distant future.

(*b*) With reference to page 2, lines 22, 23, and 24, it is my opinion that the National Science Foundation would receive more substantial assistance in the development of this research program if a special

commission comprised of meteorologists and scientists in private life be appointed to carry out the objectives for the development of an appropriate research program.

This suggestion is based in part on experience gained from the evaluation program of the Advisory Committee and in part from observations of other Government-sponsored projects.

(*c*) Page 3, section 3 is a very important provision of this bill. If the National Science Foundation is to carry out its responsibilities, it is most essential that it should have the same authority and the same responsibilities as the Advisory Committee on Weather Control had in Public Law 256. It must have access to information on commercial cloud-seeding operations to insure close coordination, unnecessary duplication, and a free exchange of ideas in order that maximum results may be obtained from Government-sponsored research program. For example, possible contamination of control areas by commercial cloud seeding might give very misleading results.

(*d*) A provision which would permit the National Science Foundation to receive appropriations which would be effective over a period of 5 years. This provision is desirable for stability and continuity of basic and applied research.

Subject to the above suggested changes, I recommend favorable consideration of Senate bill S. 86 at the earliest practicable date.

That completes my statement, Mr. Chairman.

Mr. RHODES. Are there any questions?

Mr. LOSER. Mr. Chairman, I have this one. I note on page 2 at the bottom of your statement you refer to statements made by Senator Lyndon B. Johnson and Dr. Edward Teller. Do you have those statements?

Mr. ORVILLE. I do have them and I can read the statement by Senator Johnson.

Mr. LOSER. I wouldn't care for you to read it, but I do want to ask the chairman's consent that it be inserted into the record.

Mr. RHODES. Without objection, it will be done.

(The statements referred to follow:)

INFORMATION SHEET FOR THE PRESS

Today the Chairman of the Advisory Committee on Weather Control, Capt. Howard T. Orville, United States Navy (retired), suggested that the following questions and answers would provide background for the press release issued today by the committee.

1. What is the Advisory Committee on Weather Control?

It is a small, temporary Federal agency. The committee itself is composed of 5 members from private life in the fields of science, agriculture, and business and 6 members from interested Government departments and agencies.

2. How was the Advisory Committee created?

In 1951 Senator Case of South Dakota, Senator Anderson, of New Mexico, and Senator O'Mahoney, of Wyoming, introduced bills calling for a Federal look into rainmaking or whether modification. The Senate held extensive hearings and, in 1952, Senator Case introduced a bill to create the Advisory Committee. The Congress passed this bill in 1953 and it was signed into law by President Eisenhower August 13, 1953. On December 9, 1953, the President appointed the members from private life and on December 18, the chairman called the members to their first meeting. The committee received its first appropriated funds on July 1, 1954. During the first 6 months it carried out preliminary studies, took a number of field trips, and called a number of conferences with scientists familiar with the field. By January 3, 1955, it had determined on its approach to the problem and had selected and put to work a competent staff.

3. Why was the Committee created?

Some early experiments, sponsored by the Government and by private groups, showed that man could modify clouds and initiate precipitation, with dry ice or silver iodide, under certain circumstances. This was found out in 1946 in the United States and confirmed in Australia in 1947. Some persons quite suddenly jumped to the conclusion that this might revolutionize the weather of the world. Several commercial concerns began selling their services as cloud seeders, carrying out experiments but holding out the promise that these would produce impressive increases in precipitation. Other persons expressed skepticism about the whole business. The subject became highly controversial, among scientists and among farmers, ranchers, and other water users.

Seeking to settle the controversy, the Congress established the Advisory Committtee, and in support of its request for its first appropriation, Senator Case said:

"If the Advisory Committee finds that weather modification experiments cannot produce important results, it will so report and thus deter farmers and ranchers from spending their money unwisely. This will, if such a report has to be made, save the public millions of dollars.

"If the Advisory Committee finds that weather modification activities work only in certain circumstances, it will find out what those circumstances are and thus encourage feasible projects and discourage those which are not feasible.

"If the Advisory Committee finds out it can confirm the results claimed by the reports it has so far received from reputable and scientifically competent operators—increases of from 7 to 50 percent and more—then the dollar benefits to agriculture, industry, and government will be so great as to be incalculable."

4. And what has the Committee found?

It has found through its statistical evaluation that cloud seeding, by means of commercial technique which involves releasing into the atmosphere silver iodide smoke from ground generators produces results which are significant on the west coast. Average increases in storms seeded amount to 10 to 15 percent over that which would have fallen from natural sources.

5. Are precipitation increases of this magnitude (10 to 15 percent) economically important?

An economic study conducted under the supervision of A. M. Eberle, dean of agriculture of South Dakota State College and vice chairman of the Committee, showed that a 1 percent increase during the crop-growing season could pay for the costs of a cloud-seeding operation. Cloud seeding with the use of ground generators releasing silver iodide is inexpensive compared to the value of water apparently obtained. Utility organizations in the Pacific coast area seem to have no doubts as to the value of the precipitation increases they get.

6. Can cloud seeding supress hail?

Cloud seeding to suppress hail looks hopeful though conclusive statistics are entirely lacking up to the present time. Theoretically cloud seeding of a potential hail-producing storm should initiate rain before it has developed into a hail shower. Research on hailstorms is urgently needed and is being recommended by the Committee.

7. Can cloud seeding inhibit lightning?

The severe storm conditions which produce hail are often those which produce lightning. Very possibly the same methods for stopping hail can also stop lightning. Lightning, of course, is one of two principal causes of forest fires and, understanding this, the Department of Agriculture has initiated a research project in Idaho and Montana called Project Skyfire. The Advisory Committee on Weather Control has cooperated with the group carrying out this project.

8. Have A-bomb explosions modified weather?

The language of the law setting up the Advisory Committee (Public Law 256, 83d Cong.) states that the Committee shall "study and evaluate public and private experiments designed to modify weather." An atomic-bomb explosion is not an attempt to modify weather and that is not a concern of the Committee, strictly speaking. However, the Committee has an interest in all activities which may affect or modify weather, first, because of the general concern that all citizens should have over weather factors and, second, because they may suggest ways in which man may affect weather to his benefit. The Chair-

man of the Committee has, therefore, appointed a panel of outstanding experts, including a member of the Atomic Energy Commission, to study this question. It has made a report which does not support the theory that the test explosions have significantly affected the weather, harmfully or otherwise. The question is complex and difficult and the evidence fragmentary. The Committee feels the subject warrants further and continued study and is so recommending in its final report which will be issued December 31, 1957.

9. Does the Federal Government regulate cloud seeders?

The Federal Government does not regulate cloud seeders but the law creating the Advisory Committee on Weather Control specifies that they shall submit reports on their operations—so that the Government, through the Advisory Committee, can keep track of and evaluate their operations in the public interests. The Committee does not now recommend that the Federal Government further regulate the cloud seeders other than to continue to obtain such information.

10. What about the future of weather modification?

The Committee has found (*a*) average precipitation increases of from 10 to 15 percent in one area of this country and (*b*) an apparent decrease in hail frequency in at least one area. These findings do not set limits on the possibilities for weather modification; instead they now establish a firm basis for accelerated research which will most likely lead to a greater degree of control over the atmosphere.

The Federal Government is in a position to promote and accelerate weather modification research developments which may prove of commanding importance to every citizen. It can do this by (*a*) continued surveillance and evaluation of efforts in the field, (*b*) carrying out practical experiments to improve presently known techniques and (*c*) encouraging and supporting basic research. The committee's final report advocates a research effort on a much greater scale than at present.

11. Will it be possible to eventually control weather?

If we accept the opinions of several of our leading scientists in the United States the answer is "yes".

Dr. Edward Teller in recent hearings before the Senate Military Preparedness Committee in elaborating on the danger we face unless something is done to match Russia's scientific effort, noted that we could become a "second-class power" without a war should Russia succeed in controlling weather to a point where it can produce rain over vast areas of its own territory and deprive us of needed moisture.

He said he was more confident of getting to the moon than changing the weather but the latter "is a possibility. I would not be surprised if (the Russians) accomplished it in 5 years or failed to do it in the next 50."

Dr. Joseph Kaplan, a noted physicist and chairman of the United States National Committee of the International Geophysical Year (IGY) predicts that "ocean levels will rise at least 40 feet and inundate vast areas of the earth in the next 50 or 60 years unless atmospheric temperatures are controlled". He ascribes this temperature rise to man's "tremendous use" of oil and gas.

The late Dr. John von Neumann: "Probably intervention in atmospheric and climatic matters will come in a few decades, and will unfold on a scale difficult to imagine at present".

If an unfriendly nation solves the problem of weather control and gets into the position to control the large-scale weather patterns before we can, the results could be even more disastrous than nuclear warfare. To quote Dr. Henry Houghton: "I shudder to think of the consequences of a prior Russian discovery of a feasible method of weather control. * * * International control of weather modification will be essential to the safety of the world as control of nuclear energy is now. Unless we remain ahead of Russia in meteorology research the prospects for international agreements on weather control will be poor indeed. An unfavorable modification of our climate in guise of a peaceful effort to improve Russia's climate could seriously weaken our economy and ability to resist."

The Impact of Weather Control on the Cold War, by Capt. Howard T. Orville, USN (Retired)

As much as we dislike it, today we are engaged in a cold war with a nation and its satellites whose leaders are stark realists and who will stop at nothing to achieve their objective—the absolute domination of communism throughout the world. President Eisenhower, in his recent state of the Union message, stated, "The threat to our safety and to the hope of a peaceful world * * * is Communist imperialism."

One way of achieving this goal is by means of a worldwide propaganda campaign to lower the stature of the United States in the eyes of the Western Powers. It may well be assumed that they are constantly searching for new sources of material in waging this campaign.

Only last week when the Army successfully fired the Explorer were we able to partially recover some prestige from the terrific loss sustained when the Russians fired two satellites into space. One is still orbiting around the earth. This experience should have taught us that we must he constantly on the alert for seeking the propaganda advantage over the Soviets.

If you will think back to September 1957 or earlier, you will recall that perhaps not one person in a million would have predicted the successful launching of a satellite that would orbit the globe for months. Fantastic! Unheard of! Impossible!! would have been some of the remarks received.

This, then, is an experience very fresh in our minds and should make us aware of the fact that the impossible may become a reality long before the best scientific or military brains can even envisage such an eventuality. In the past we have been slow in assessing the propaganda value of scientific achievements. Let's hope that the future will see us more clairvoyant.

This brings me to the subject of the discussion today—the impact of weather control on the cold war. Few areas of science have implications so profound to all mankind as the study of the atmosphere and the phenomena which occur in it.

Perhaps it would be appropriate to define the term "weather control." Weather controls means that our knowledge of atmospheric processes has reached the level where we are able to apply manmade techniques to large scale weather patterns to start a chain reaction that will produce known results over a specific portion of the globe for a known period of time. For example, if an unfriendly nation were able to bring about the recurring destructive cold spells that have plagued Florida for the past 2 months, this would be absolute weather control.

Prior to the sputnik era the best scientific opinion was that the day of weather control was perhaps 30 to 60 years away, maybe even longer. When, in 1954, I suggested that with the expenditure of $11 billion over a period of 30 to 40 years we might achieve complete weather control, I was severely criticized by my contemporaries.

Since October 1957 there have been many statements (some far too optimistic) by scientists of world renown. Probably one of the most significant statements was made by Dr. Edward Teller before the Senate Military Preparedness Committee. He stated that he was "more confident of getting to the moon than changing the weather, but the latter is a possibility. I would not be surprised if (the Russians) accomplished it in 5 years or failed to do it in the next 50."

What are some of the methods of achieving weather control? A number of methods have been suggested for bringing about major influences on weather or climate. To date none of them can be called effective methods of weather control because, if applied by any nation, no one knows what would be the resulting action of such drastic intervention on our own country or that of other nations. Until we are able to predict with certainty what will happen when manmade methods are applied, weather control should not be attempted.

USE OF COLORED PIGMENTS (LAMP BLACK)

One method of controlling the weather that has often been mentioned is the large scale use of colored pigments over the polar ice surfaces. It is well known that the persistence of large ice fields is due in part to the fact that ice both reflects sunlight energy and radiates away terrestial energy at even higher rate than land surfaces. If microscopic layers of colored matter were spread on the ice or in the air above it, it would alter the reflection-radiation balance, melt the ice, and change the local climate. Measures that would bring about such a change are technically and economically feasible.

WARMING CAUSED BY INCREASED CARBON DIOXIDE CONTENT

The carbon dioxide that is released to the atmosphere by industry in the burning of coal and oil and their derivatives (most of it during the last generation) may have changed the composition of the atmosphere sufficiently to bring about a general warming of the world's temperature by about 1° Fahrenheit. This warming represents a 2 percent increase in the carbon dioxide content of the air. Studies show that when the amount has increased to 10 percent the icecaps will begin to melt with the resulting rise in the sea level. Coastal cities and areas such as New York and Holland would be inundated.

COOLING CAUSED BY RADIOACTIVE "DUST"

When the volcano Krakatao erupted in 1883 it released an amount of energy by no means exorbitant. If the dust of the eruption had continued to circle the globe at high altitudes for 15 years instead of only 3 years, it would have lowered the world's temperature by 6°. Five such eruptions would have brought another Ice Age. This temperature is only about 15° below the present world's temperature.

Dr. Teller has testified in congressional hearings that if 2,000 H-bombs were to be exploded over a period of 20 years, the "dust" floating around in the stratosphere would be sufficient to cause a cooling to bring on a new Ice Age. This, of course, discounts the possibility that the "dust" might serve as freezing nuclei.

ARTIFICIAL SATELLITES AS PLATFORMS FOR WEATHER CONTROL

Weather satellites equipped with powerful telescopes and television attachments could chart cloud movements, detect the birth of hurricanes or other severe storms, and vastly improve our surveillance of weather patterns.

Dr. Hermann Oberth, of Germany, foresees a gigantic mirror "hung" in space. It would focus the sun's rays as giant magnifying glass at any desired intensity and beam. The sun's rays could light entire cities or other areas safely at night. The heat of the rays might be used to prevent killing frosts over orchards, or melt Atlantic icebergs, open frozen harbors, and probably bring about artificial control of the weather.

Senator Lyndon Johnson of Texas stated recently: "From space, the masters of infinity could have the power to control the earth's weather, to cause drought and flood, to change the tides and raise the level of the sea, to divert the Gulf Stream, and change temperate climates to frigid."

I have read that at least twice in the past 12 months Moscow has boasted of large public works projects that would upset the entire wind circulation pattern of the Northern Hemisphere; conducted numerous nonpublicized but still detectable experiments apparently aimed at finding ways to speed the melting of polar icecaps; and has even offered to join the United States in a project to turn the Arctic Ocean into a sort of warm water lake by melting the polar icecap.

Russia's apparent preoccupation with plans to change the climate of the Northern Hemisphere is easy to understand. The Soviets and their satellites stand to profit more, from an economic standpoint, than any other combination of nations.

The proposal to turn the now frozen Arctic Ocean into a warm water lake came over Moscow radio just 3 days after last Christmas.

A Russian engineer, Arkady Borisovich Markin, proposed that a team of international scientists cooperate in designing a dam to redirect the waters of the Pacific Ocean to relieve the severe cold of the Northern Hemisphere. Such a dam built across the Bering Straits would be fitted with thousands of nuclear energy powered pumps that would pump the warmer waters from the Pacific into the colder Arctic Ocean. At other times the pumps on the Bering Straits would pump the water from the Arctic Ocean to the Pacific, canceling out the Greenland, Labrador, and other cold oceanic streams.

Just how such a plan would work is not clear to me; but if, as Markin states, the dam would raise the temperatures of such cities of New York, London, Berlin, Stockholm, and Vladivostok 11° to 14½°, then the melting of the icecaps and the release of landlocked waters would cause seacoast towns and cities to be flooded by the expected rise in the sea levels. This means that Russia might then enjoy warm water ports and mild temperatures similar to our South Atlantic States, but at the expense of great flooding of the Western nations' coastal areas.

Other great schemes for Russian public works programs to divert the course of several of its rivers from the Arctic Ocean to the Caspian Sea are less dramatic, but might eventually upset the present weather patterns over Siberia, which in time would affect the weather around the Northern Hemisphere.

There are many other methods by which effective weather control may be practiced by an unfriendly nation, but they are too numerous to even mention by name.

A moment's consideration of any of the methods mentioned here today should serve to convince any skeptic that weather control can have frightening and disastrous consequences if any unfriendly nation succeeds in gaining a breakthrough before we do.

This is, I think, what Dr. Teller meant when he recently stated:

"The Russians can conquer us without fighting through a growing scientific and technological preponderance. The Russians may advance so fast in science and leave us so far behind that their way of doing things will be "the way," and there will be nothing we can do about it. Imagine, for instance, a world in which the Russians can control weather on a big scale, where they can change the rainfall over Russia. This might very well influence the rainfall in our country in an adverse manner. What kind of world will it be where they have this new kind of control and we do not?"

Now, what courses of action can we take to get out of our present extremely vulnerable position for future Soviet propaganda attacks in the field of weather control? There are two important steps that must be taken.

First, see that Senate bill S. 86 is passed. Fortunately, through the vision and courage of several Members of Congress, notably, Senator Francis Case, of South Dakota; Senator Clinton Anderson, of New Mexico; Senator Arthur Watkins, of Utah; and Senator Warren Magnuson, of Washington, there is now pending in Congress a bill, S. 86, to set up a permanent research program under the National Science Foundation for an accelerated study in all aspects of atmospheric physics. When this bill, which was originated by Senator Francis Case, is passed and is aggressively implemented it will provide for the urgently needed program in basic and applied research.

Second, there must be an awareness and an appreciation of the valuable service that the United States Weather Bureau is performing today under most stringent circumstances. It is understaffed; much of its equipment is obsolete; research facilities are practically nonexistent; its research program is far below that which it should be during these critical times; and the prospects for getting the funds needed to correct these deficiencies are very poor. Other weather services of the Defense Department dealing primarily with military applications of weather control should be given strongest possible support.

Since weather control is an ideal tool for waging the relentless cold war against the Western Powers, we must not become complacent and we must not be caught as we were when Sputnik I was launched last October.

We must take seriously the truth of Vice President Nixon's statement, "the Kremlin has reaffirmed its goal of world domination by nonmilitary means if possible, and by war if necessary."

Weather control has many important nonmilitary applications and just as many military uses.

Mr. RHODES. The next witness is Mr. Eberle.

STATEMENT OF DEAN A. M. EBERLE, SOUTH DAKOTA STATE COLLEGE, BROOKINGS, S. DAK.

Mr. RHODES. Mr. Eberle is formerly the Vice Chairman of the Advisory Committee on Weather Control and is now the dean of South Dakota State College.

Mr. EBERLE. Mr. Chairman, with your permission, I would like to read my statement, which is not too long.

Mr. RHODES. Proceed.

Mr. EBERLE. My name is A. M. Eberle, dean of agriculture of South Dakota State College, Brookings, S. Dak., past Vice Chairman of the Advisory Committee on Weather Control, chairman of the South Dakota Weather Control Commission.

I have been connected with the college for the past 36 years. I have been connected with weather modification or cloud seeding in South Dakota since 1951 when farmers in my State contracted with private seeders to increase rainfall.

At our institution we evaluated the work of the operators, as best we could and have constantly advised with farmers relative to this important work.

South Dakota had at one time 12 million acres under contract with private cloud seeders. The 4-year summary made by State College of the seeding operations showed a 9-percent increase in rainfall, over that which would have fallen naturally. It was difficult to get a good correlation because all areas did not seed the same length of time. The result would have been higher had the seeding dates been the same for all areas. We were sort of pioneers in this matter of evaluation. Since then the Advisory Committee on Weather Control has developed a better method of evaluation and we feel probably if we had gone back in our records we could have indicated that there would have been a greater than 9-percent increase.

In the Great Plains a considerable number of studies have indicated that, in the case of spring wheat, 1 inch of precipitation, above the 5 to 10 inches, is associated with a yield increase of 1.5 to 3.5 bushels per acre.

We can figure that the ratio of increase in yield to increase in precipitation is 2 to 1 over a base of a minimum of 8 inches, or in other words, 1 inch of rainfall over the minimum will yield 2 bushels of wheat.

Over most of the Great Plains the annual average precipitation is so close to the amount required for growing grain crops that the sizable natural fluctuations in precipitation are of extreme significance. In other words, in South Dakota, we say we have rainfall at the margin. An inch of rain over the margin will give us a good crop and an inch of rain below the margin gives us almost a complete failure. That is why we consider this matter of cloud seeding so important in our State.

All of the cloud seeding has been done in the spring. We are finding that fall seeding also has great possibilities. Increasing the fall rainfall, means storing water in the ground and building up the subsoil moisture. If this is done consistently year after year, it will have a real effect in minimizing any prolonged drought period.

Testimony concerning S. 86 to provide for an experimental research program in cloud modification was heard in the Senate on March 26 and May 13, 1957.

I testified at that time the need for research in weather modification and that S. 86 would make that possible.

There was evidence presented at that time by farmers and ranchers, as well as by representatives of scientific and technical groups, who also were strongly in favor of the passage of the bill. Since that time, events have occurred which serve only to heighten the urgency of getting it passed into law, so that steps can be taken at the national level to explore more fully the vital natural resources of our weather.

Early in 1958, volumes I and II, of the Final Report of the President's Advisory Committee on Weather Control were released to the public. There is no need for me to recapitulate the findings of those

volumes further than to state that statistical and physical evidence was produced that showed the effect of artificial stimulation on cloud structures in specifically delineated conditions.

Evidence, indeed, was of such a caliber as to encourage further basic research in cloud processes and precipitation mechanisms in order that subsequent engineering procedures with regard to weather modification practice can be developed and improved.

The people of South Dakota, always pioneers in this field, have sufficient faith in the ultimate benefits to be derived from such studies that they are continuing in a modest way to sponsor basic research and weather modification field studies through the efforts of the State weather control commission and personnel on the staff at State college.

With the passage of S. 86, South Dakota will be prepared and ready to cooperate with the National Science Foundation.

To quote Dr. Henry Houghton's December 1957 statement to the American Meteorological Society. This, I think, is a very important statement by Dr. Henry Houghton who is the chairman of the meteorology department at MIT, and one of the recognized authorities in this country on weather modification. He says—

> All to often we Americans confuse technological progress with research. Basic research is the search for an understanding of nature's mysteries with no immediate practical application in mind. The life-blood of technological progress is the result of such basic research and we can no longer depend on other countries to supply this vital plasma.
>
> Basic research in meteorology can be justified solely on the economic importance of improved weather forecasting but the possibility of weather control makes it mandatory.

Dr. Houghton also says—

> From the reports now reaching us from many sources it is clear that the Russians have a very large meteorological research effort. Since the beginning of October no one has any question of the scientific ability of the Russians and their meteorological research is first-rate. I shudder to think of the consequences of a prior Russian discovery of a feasible method of weather control.
>
> Fortunately for us and the world, we were first to develop nuclear weapons, even though we had to depend heavily on the basic research done in other countries. International control of weather modification will be as essential to the safety of the world as control of nuclear energy is now. Unless we remain ahead of or abreast of Russia in meteorological research the prospects for international agreements on weather control will be poor indeed. An unfavorable modification of our climate in the guise of a peaceful effort to improve Russia's climate could seriously weaken our economy and our ability to resist.

The Advisory Committee on Weather Control offered a long list of suggested projects, in which I concur. Part of this list includes such important studies as—

(1) a study of solar influences on weather,

(2) the factors that control global circulation,

(3) the factors that control the genesis and dissipation of storms such as hurricanes, tornadoes, blizzards, etc.,

(4) electrification process in clouds,

(5) the role of condensation nuclei and many others.

I believe that S. 86 should be amended to include the following. These recommendations are the results of our conferences in South Dakota with farmers and staffs at the State college.

1. That the research undertaken include basic, applied, and engineering research.

2. That a committee be established by law in the National Science Foundation composed of 5 scientific members and 6 lay people to be an advisory committee to the National Science Foundation.

3. The several Federal agencies should not be members of the committee, but could or should be technical advisers to the committee.

4. The National Science Foundation to be coordinator for all research supported by Federal, or Federal-State appropriations.

With these thoughts in mind, and since the urgency of the situation is now being so generally recognized, I believe my testimony can be brief.

If the United States is to continue as a leading power, we must get answers to many of the queries now facing the cloud physicist, chemist, meteorologist, and student of atmospheric science.

This can only be done by developing a well coordinated program of research, endowing it with adequate financial support, and putting it item by item, into the hands of competent and enthusiastic teams of research workers to carry through. I believe that S. 86, with a few amendments, is the answer to that problem.

That is my statement, Mr. Chairman.

Mr. RHODES. Thank you. Are there any questions?

Mr. BUSH. What method of seeding the clouds have you used?

Mr. EBERLE. Up to this time we have used entirely, would you say. the ground method, using ground generators for seeding the clouds. We did some experimental work with National Guard planes, as we had permission from our Governor, and we used both the jet and high-altitude planes, and we did seed clouds by that method, and that was only a year ago, in the spring, when we had thunderheads and clouds that were susceptible to that program.

Mr. BUSH. What did you use for seeding the clouds?

Mr. EBERLE. At that time we used dry ice.

Mr. BUSH. Has there been anything found that is better than dry ice for seeding the clouds that you know of?

Mr. EBERLE. Outside of silver iodide; no. We do use silver iodide for ground generators and dry ice for airplanes, although, this year, starting on the 15th, we are going to use silver iodide in airplanes.

Mr. BUSH. When you seed the clouds in South Dakota do you control the rainfall that you will get there or do the clouds drift and cause the rain to fall in some other area?

Mr. EBERLE. Well, that is very apt to happen. I think we are learning to seed them so it will fall just about where you would like it to fall, but on some of the experiments on weather control it has shown targets were made and yet it proceeded downwind.

Mr. BUSH. We could use some of that. I was wondering if you could get those clouds to come over to Pennsylvania.

This is a very interesting subject. It is something that is very, very serious and very worthwhile. It is a matter that concerns all of us. This matter of seeding the clouds or of trying to produce moisture for our soil is very important.

Now how about snow? Are you trying to seed the clouds so we can get snowstorms, too?

Mr. EBERLE. We would like to, but our farmers won't approve of it because they have had too much experience now in trying to dig themselves out and in trying to get to town and so forth; and so far we have not done that.

Mr. BUSH. According to my information, snow provides a lot of moisture and is very beneficial to the soil and I was wondering if you had done any experimenting along that line?

Mr. EBERLE. We have. I think one of these times the farmers will consent to let us do that.

Mr. RHODES. Thank you, Dr. Eberle.

STATEMENT OF JACK C. OPPENHEIMER, SOLICITOR'S OFFICE, DEPARTMENT OF THE INTERIOR, WASHINGTON, D. C.

Mr. RHODES. Our next witness is Mr. Jack Oppenheimer, formerly executive secretary of the Advisory Committee on Weather Control. He is now in the solicitor's office of the Department of the Interior.

Mr. OPPENHEIMER. Mr. Chairman, I should like to read a short statement, if I may.

Mr. RHODES. Proceed.

Mr. OPPENHEIMER. Mr. Chairman, my name is Jack C. Oppenheimer.

In view of my service as executive secretary and counsel to the Advisory Committee on Weather Control, I was invited by your committee to testify on this proposed legislation. I shall be happy to furnish information and answer questions which are within my competence and authority.

I should like to state that I am at present an attorney in the Office of the Solicitor of the Department of the Interior. While the Interior Department has no objection to me appearing before your committee on this proposed legislation, my testimony in no way is intended or authorized to reflect the views of the Department of the Interior, and represents only the views of the Advisory Committee on Weather Control as expressed in its official reports or my personal opinion.

Subject to the pleasure of the committee, I should like to make a short statement prior to answering any questions the committee may have. If the record of this hearing does not already include it, I believe it would be helpful to insert the legislative recommendations of the Advisory Committee on Weather Control appearing on pages 26 and 27 of volume I of its final report and appropriate reference to both volumes I and II of the final report of the Advisory Committee on Weather Control, dated December 31, 1957.

LEGISLATIVE RECOMMENDATIONS

In accordance with section 3 of Public Law 256, 83d Congress, as amended (15 U. S. C., sec. 311 note), the Advisory Committee shall make a study and evaluation of weather modification or control activities for the purpose of determining the extent to which the United States Government should experiment with, engage in, or regulate such activities. Section 10 (a) of this act requires the committee to submit reports on its findings and recommendations to the President from time to time, for submission to the Congress. At the earliest possible moment, and not later than June 30, 1958, it must submit a final report on its work as well as recommendations on the advisability of the Federal Government's regulating, by means of licenses or otherwise, those who attempt to engage in activities designed to modify or control the weather. The date for this final report was changed to December 31, 1957, by the Supplemental Appropriation Act for fiscal year 1958.

The committee's investigations suggest that the limitations inherent in the geographical jurisdiction and technical administration of the meager case law

and the few State statutes cannot prevent cloud seeding under the wrong meteorological conditions or by professionally unqualified or poorly equipped operators. The State laws do not contain the authority to cope adequately with the physical and legal problems produced by cloud-seeding activities conducted relatively close to State and National boundaries.

Although it is well aware of these problems, the Advisory Committee on Weather Control believes that the most pressing need is for basic and applied research under scientifically controlled conditions and for a sufficiently long period of time to yield results which can be analyzed and evaluated in the public interest. For this reason, the Advisory Committee recommends the enactment of S. 86, 85th Congress. This legislation authorizes and directs the National Science Foundation to initiate and support a program of study, research, and evaluation in the area of weather modification, in consultation and cooperation with Federal, State, and private agencies.

The National Science Foundation research program should be implemented by substantially the same legal authority given to the Advisory Committee to obtain information. Such action is necessary if the Foundation is to obtain the necessary information from all private and public persons and organizations conducting weather modification activities. The authority of the National Science Foundation to obtain such information under S. 86, if enacted into law, should be clarified and made certain. This is necessary in view of the ambiguity of meaning introduced into section 3 of S. 86 by the language of the appropriation item for the Advisory Committee in the Supplemental Appropriation Act for fiscal year 1958. Authority to obtain information should make explicit the discretionary power of the National Science Foundation to require prior notice of the objectives, times, places, and methods of weather modification activities as well as periodic reports of operations after they are undertaken. Where some States have specific statutory authority or general police power to require such notices and reports, the National Science Foundation should make appropriate cooperative arrangements with these States to obtain the necessary information. (The constitutional framework within which this should be done is discussed, together with other legal and legislative aspects, in the section on the Legal Situation in volume II of this report.)

Consistent with the Advisory Committee's legislative recommendations, a member of the staff of your committee communicated with me with regard to clarifying and making certain that H. 86 contain substantially the same legal authority in one respect given to the Advisory Committee so that the National Science Foundation would be assured of obtaining necessary information for its program of study, research, and evaluation from all private and public persons and organizations conducting weather modification activities.

It was the Advisory Committee's hope that this matter of authority to gather necessary information would require clarification only in the report of your committee without necessitating an amendment and further Senate action after action by the House.

However, after consultation, it was our opinion that the intent and purpose of the Advisory Committee's recommendations would be accomplished with certainty by the elimination of all of the language of section 3 of the bill to the phrase "there is authorized" and the addition of section 9 of the Advisory Committee on Weather Control Act of August 13, 1953 (Public Law 256, 83d Cong.), as amended, by insertion by reference at line 21 of section 2 of the bill or by the inclusion of new language in some other appropriate place.

Both prior to and subsequent to consultation with your staff member on this matter of authority to gather necessary information, I discussed it with legal counsel for the National Science Foundation. It is my understanding informally that these methods of implementing the Advisory Committee's recommendations are in accord generally with the views of the National Science Foundation.

As to the other provisions of the bill, I believe it would be more appropriate to have the views of the National Science Foundation witnesses. I have reference particularly to the relationship of the language in section 2 to the powers granted already by the National Science Foundation Act and to the proposed amendment using provisions of section 9 of the Advisory Committee on Weather Control Act.

That concludes my prepared statement, Mr. Chairman.

Mr. RHODES. Are there any questions?

Thank you, sir.

STATEMENT OF JOHN L. DI SANTO, FIELD DIRECTOR, WATER RESOURCES DEVELOPMENT CORP., DENVER, COLO.

Mr. RHODES. The next witness is Mr. John L. Di Santo, field director, Water Resources Development Corp., weather modification projects, 460 South Broadway, Denver 9, Colo.

You may proceed, Mr. Di Santo.

Mr. DI SANTO. Mr. Chairman, I would like the permission of the committee to read my prepared statement.

Mr. RHODES. Proceed.

Mr. DI SANTO. Also, I would like to state to the committee that Dr. Irving P. Krick, the president of our organization, extends to this committee his sincere regrets for his inability to be here and he has submitted a letter to the clerk of the committee which he asks to be included in the record.

Mr. RHODES. Without objection, it will be done.

(The letter referred to follows:)

WATER RESOURCES DEVELOPMENT CORP.,
Denver, Colo., March 12, 1958.

Mr. W. E. WILLIAMSON,
Clerk, Committee on Interstate and Foreign Commerce,
House Office Building, Washington, D. C.

DEAR MR. WILLIAMSON: I regret to inform you that prior commitments will not permit my personal attendance in Washington on Tuesday, March 18, 1958, to testify before the Subcommittee on Health and Science regarding S. 86.

However, our corporation has prepared a statement of policy relative to bill S. 86, five copies of which are enclosed. Our Mr. J. L. Di Santo will be in Washington to present this testimony on behalf of our corporation.

I should consider it a favor if you would introduce this letter as a summary statement of my personal beliefs concerning weather modification, or its ultimate evolvement into weather control. Briefly, they are as follows:

1. Weather modification and weather control shall, in the next few years, be universally recognized as a science.

2. The physical application of this science will greatly assist mankind in the betterment of his environment and personal economic position. It will aid in the elimination of unrest attached to low living standards.

3. The Nation that first acquires control of the weather shall be the leading power in our world. This position could be accomplished in a relatively short period of time and, unfortunately, could be going on undetected. In other words, world invasion could be activated and maintained without the detection by the defensive nations until too late.

4. It is imperative that our country win this race.

5. Private enterprise and courage and faith of the individual American has progressed this science to its present level. This has been achieved in spite of heavy and hindering pressures of negative attitudes prominently displayed by governmental bureaus and some groups at college and university levels.

6. It is not only important but it is a must that this legislation, if passed, receive careful attention and implementation. Heavy responsibilities, the safety

of our Nation depends upon due consideration and mature judgment in the administration of this vital work.

7. There are many groups within our country today that will advocate heavy, basic research with little or no attention to the equally important applied engineering phases of the problem. Where would we be today if we had continued basic research on automobiles, aircraft, etc., say for 20 years before producing a model car. I stress we need an accelerated well-balanced program, including the actual field operational work if we are to proceed upon a sound, logical, and developmental trend that will insure that we find the answers first.

8. Basic research is necessary but again I stress the importance of the other phases. For instance, during the last 15 years we have been engaged in a missile race. We have found that all the laboratory and basic research work means little if the missile won't get off the ground. We are now engaged, by testing—trial and error—in discovering the flaws and how to correct such problems. This is true in any field of endeavor wherein we try to push our frontiers of knowledge forward.

9. I strongly recommend that those groups that have experience in this field, and I refer to the private operators, must be given due and proper consideration in the chance to participate in the funds that will be available under this legislation. Let's not channel into a restrictive field—either private, governmental, or college level.

10. I recommend that a committee or board be set up within the National Science Foundation to administer this appropriation. It should be composed of scientists and laymen, with no members from governmental agencies or private operators.

11. Above all, let us not lose time—and I speak of this advisedly. We do not want this important work pushed back into the laboratories for 10 years to rehash all that has been done—just for the mere satisfaction of scientists with negative attitudes. Time is precious and should not be wantonly wasted.

I respectfully submit all the foregoing as my true beliefs and feelings. I thank the committee for this opportunity of presenting my views and sincerely regret that I could not change my schedule to personally appear.

Sincerely yours,

IRVING P. KRICK.

Mr. DI SANTO. First, Mr. Chairman, may I express my own thanks and appreciation for this privilege of appearing before you.

My name is John L. Di Santo and I am field director of the Water Resources Development Corp., a private enterprise organization actively engaged in the operation of weather modification programs throughout the world.

INTRODUCTION

Mr. Chairman and members of the committee, during the relatively short time that our great country has been in existence, we have been singularly blessed with men and women of vision, courage, and inventiveness. Starting with the Declaration of Independence in 1776 to this year of 1958, which is only a very short 182 years compared to the history of other nations, our country has progressed from an undeveloped group of 13 Colonies to the greatest industrial power in the world. These blessings have come to us because of our unbounded faith in God and in our willingness to put our trust entirely in Him, combined with our own desire of accomplishment.

This great development required, first of all, men and women who were able to project their vision into the future and plan a system of free and democratic government that would guarantee this development.

Second, it required men and women of courage to come from civilization to the uncivilized New World. In spite of the ridicule and unbelief on the part of the majority of the world that our democracy

would not work and would soon disappear, they had the determination to forge ahead and make it work.

Third, it required men and women of inventiveness who were not afraid to come to grips with scientific problems which would result in obtaining for our people the high standards of productivity and the abundance of living which has now become the goal of the entire world.

These men and women of vision, courage and inventiveness have included people from all walks and stations of life and their numbers are legion. They did not come from one class or group, but rather represent a complete cross-section of our free and democratic people.

Our accomplishments have been the result of cooperative efforts of Government, business, labor, and agriculture, operating under a system of free enterprise. The individual has the freedom to develop such ideas, theories, beliefs, or projects as he may desire. Government has not promulgated edicts to prevent him from this development but instead in many instances when the public welfare is involved, has assisted and encouraged him both morally and financially.

The Congress of the United States has been called on many times in the past and is being called upon today to render such assistance. This great body, representative of all of our people, has analyzed and digested the facts in many situations which involve the welfare of our people.

Here, also, as in any walk of our national life, men and women of vision and courage have risen to the occasion. These representatives of the people, without personal gain to themselves, have set aside political differences to champion the progression of a new science which may produce unheard-of benefits to the people of our country and possibly to the world.

The people of the United States would be remiss indeed if we did not pay tribute to their foresight and courage. First of all, to the four Senators who are sponsoring this legislation: Senator Francis Case of South Dakota, of whom, with other South Dakotans, I am especially proud, Senator Magnuson of Washington, Senator Anderson of New Mexico, and Senator Watkins of Utah, as well as to Senator Alan Bible and his committee for their excellent conduct of the Senate hearings last year.

Secondly, to the four Congressmen, also sponsoring this legislation: Congressman Hull of Missouri, Congressman Engle of California, Congressman Baring of Nevada, and to Congressman E. Y. Berry of South Dakota, my own Congressman from my own district in whom we in South Dakota have great confidence, and to you, Mr. Chairman, and to the members of this committee for your patience and kindness during these hearings.

I would also like to extend my appreciation for the appearance of one of our most capable Congressmen from the State of South Dakota, this morning, Congressman George McGovern of the State of South Dakota.

THE PAST

The Congress of the United States is now called upon to consider the further progression of a new science called weather modification and control. The scope of this program is ably outlined in Senate

bill 86. It is necessary that the United States accelerate the development of this science as rapidly as possible. We heartily endorse this view. However, we would like to present some suggestions for the careful consideration of this committee. In order to clarify these suggestions, it is necessary to review some of the history in connection with this program.

1. The first discoveries were made in the laboratories of the General Electric Corp., a private corporation, by Schaeffer, Vonnegut, and Langmuir.

2. These discoveries were engineered by private corporations for direct application in the field.

3. Thousands of farmers, ranchers, as well as private power companies, cities, and other private groups have contributed many dollars to the progress of this science over the past 10 years.

4. During these 10 years these private groups have taken a positive approach to the solution of some of the many problems in connection with this science.

5. During the same 10 years many of the Government agencies have taken a negative attitude. They have been conspicuous for their ridicule and unbelief.

6. These Government agencies have also been conspicuous for their utter lack of any constructive contributions of a positive nature.

7. The Congress of the United States, on the other hand, decided to provide for analysis and evaluation of the results obtained from weather modification operations by passing legislation in August of 1953 to establish an Advisory Committee on Weather Control.

8. This Committee, under the very capable Chairman Howard T. Orville and Vice Chairman Dean A. M. Eberle, has recently completed its report and presented the same to the President and Congress of the United States.

9. The same Government agencies who have ridiculed this program of weather modification have also stated their opposition to the continuance of the Advisory Committee on Weather Control.

10. The Advisory Committee on Weather Control—

(*a*) Made exhaustive analysis of operations conducted by private and public groups in the United States.

(*b*) Conducted physical evaluations of certain phases which have contributed a great deal of seriously needed information and data.

(*c*) Visited and met with agricultural and industrial groups throughout the United States.

(*d*) Analyzed the legal implications in this program.

(*e*) Approached this program, in spite of the direct and indirect opposition of some Government agencies, objectively and with determination to present to the Congress and the people an unbiased, frank, and honest report.

(*f*) Secured access to all the records, methods, equipment, and procedures of the private operators who have always offered their complete cooperation.

(*g*) Found indications of a positive nature in the area of increasing rainfall which more than justify the further development of this science.

11. The final report of this Advisory Committee and particularly the recommendations made in each section should become the starting place for all future research.

12. Private groups and private operators have again moved forward toward new phases of this science. These include—

(*a*) Hail suppression.
(*b*) Lightning suppression.
(*c*) Preliminary steps toward fog dispersal.

Again, ridicule and unbelief are being expressed about these new developments.

13. There were many mistakes made during the past 10 years by the private operators and groups and we are the first to admit them. Overenthusiasm to a certain degree contributed largely to these mistakes. However, with the publication of the first report of the Advisory Committee all groups adopted policies in line with these findings. Without bureaucratic methods the true perspective was set in focus. I might say, parenthetically, if the Advisory Committee had done nothing else, this, of itself, was of vital importance to the country.

14. Continuing changes in techniques and equipment are being made by the private operators to improve the results and to extend our knowledge. For example, our own organization has reengineered its ground-based generating equipment 17 times in the past 10 years and is now in the process of engineering a new model 18.

All of these changes and improvements were made entirely at the expense of the private operator. No assistance was given by any Government agency, either financially, technically, or in any other manner.

15. There are many other developments that could have been undertaken, but the private operators have been limited by the amount of capital they could spend. Their spending is controlled by their dollar volume. We know that many good potentially productive theories and ideas are being delayed because of lack of finances.

16. The accusation has been made that private operators have made "millions" from weather modification operations. It is a fact, however, that practically all of these firms have been and are struggling to make ends meet and to stay in business. Research expenditures are so heavy in addition to operating costs that profits had to be foregone.

17. Private operators and groups have realized the necessity of regulatory actions to protect the general public, and have of their own free will advocated and assisted in the introduction and passage of such legislation in 13 States. In practically every State where weather modification programs were organized, the private operators have urged the people in those States to institute such legislation. State weather control commissions, wherever established, have also been advised to utilize existing technical assistance from the universities, colleges, and even from the very agencies who have ridiculed this program.

18. The private operators have also recommended to their clients that they secure the services of independent evaluators, even using those who have been antagonistic to the program.

19. The private operators have not tried to "gouge" the people using this service, but to the contrary have kept prices at a ridiculously low level.

THE PRESENT

The science of weather modification and control has now reached the stage where accelerated development is not only possible but

necessary. This is true, not only domestically but internationally. The advances made in Australia, just to mention only one of the nations, indicate that highly important discoveries are in the immediate offing. You are, undoubtedly, familiar with some of the plans which have been reported in the press for the development of weather control by the Russians.

The economic benefits to our Nation as well as to the other nations of the world through weather control would far surpass any other scientific development in the history of mankind.

Think, if you will, of the tremendous economic implications of (1) potential elimination of droughts; (2) potential elimination of destructive elements such as hail, hurricanes, tornadoes, cyclones, et cetera; (3) fog dispersal; (4) lightning suppression—and many others.

It is hardly necessary for me to dwell on the military implications. I am confident you are well aware of the potential uses that can be made of weather control by an enemy power. It is our fervent prayer that this Congress will make it possible for our country to get there first.

The instrument which will help us get there first is in your hands, and bears the identification of Senate bill 86. This bill, which has already passed the Senate, is now to be considered by the House of Representatives and is at present in the responsible hands of this committee.

Those of us who have carried on this tremendous task during the past 10 years are determined that our country shall be first, and will continue to work toward that end. However, we need your help. We are not quacks or witch doctors. Our ranks include many of the most highly trained and experienced scientists in the world. These scientists have elected to apply their knowledge and skills through employment with free private enterprise. They are not subsidized by anyone, but believe in the free-enterprise system and prefer to work for private enterprise.

These scientists are not asking you for a subsidy, but are requesting that their skills, knowledge, and experience in the field of weather modification and control be utilized in the conduct of future researches planned under S. 86.

These scientists also feel that all research should start from the level which has already been attained during the past 10 years. Ignoring the development of the past 10 years and starting over again is a complete waste of the thousands of dollars expended during this period by the farmers, ranchers, industrial concerns, cities, and the private operators who have carried on this work. This duplication also means additional cost to our Government and, in turn, to the taxpayer.

It is also vitally important that a positive approach to the problem of both basic and applied research in the field of weather modification and control be taken by the agency charged with the administration of this bill. Applied research must not be sacrificed. Provision should be made for immediate translation of the findings of basic research into engineering methods of application. Improvement of present techniques, methods, materials, and equipment should become an essential part of the overall research program.

SUGGESTIONS

In order to provide a research program that will produce effective and immediate results, we respectfully submit, for careful consideration by the committee, the following:

1. The scope of research should be defined to include basic, applied, and engineering research.

2. The National Science Foundation should be required to establish a Committee on Weather Control composed of 6 scientific members and 5 lay members. None of these committee members shall represent a Government agency or a commercial operator.

3. The various Government agencies concerned with this program shall be designated as technical advisers to the Committee for Weather Control.

4. The commercial operators shall also be designated as technical advisers to the Committee on Weather Control.

5. The Committee on Weather Control shall be responsible for the coordination of all research activities.

6. The bill should provide a method of giving financial assistance to organized groups of farmers, industrial organizations, municipalities, and others who have been or are now conducting scientific weather-modification activities. I would like to clarify that by adding "for research purposes only, not for operations."

7. The National Science Foundation and its Committee on Weather Control shall be instructed to utilize the knowledge, skill, and experience of the private operators in the development and conduct of such research.

Mr. Chairman and members of the committee, I have pointed out earlier that our accomplishments have been the result of cooperative efforts of Government, business, labor, and agriculture under a system of free enterprise. Let us keep this highly successful formula as the bulwark of our Nation.

Let us pass this monumental heritage on to our children, even as our forefathers passed it on to us. To work cooperatively in the interest of our people is a fundamental principle of our democracy. Under our form of government, all groups, whether they be workers, farmers, financiers, industrialists, scientists, or government agencies, are servants of all the people. It is not necessary under our free government to develop any ruling classes or "new classes." We are all part of the whole, and the whole is part of us.

Mr. RHODES. We appreciate your very fine statement, Mr. Di Santo. Any questions?

Mr. BUSH. I would like to ask him this question: Have you had much experience with work that has been done to produce rain in these various areas?

Mr. DI SANTO. Yes, sir; I have been part of many, many projects in the United States. I am not a meteorologist, but I have watched the operation of all of these projects in the country, as well as in Canada and Mexico.

Mr. BUSH. Do you find that some of the clouds which they seed in trying to get rain are dry clouds and you do not get moisture?

Mr. DI SANTO. In the early days, we seeded all types of clouds because we were still learning. As we progressed and I began to analyze

the effective results and the effective levels, we began to discriminate in the choice of the type of cloud that would produce the best results. That is why in the past 3 years the results have been much more significant than in the first 7 years. We learned to crawl before we started to walk.

Mr. BUSH. That was a very fine statement. Thank you.

Mr. NEAL. Mr. Di Santo, your organization is a private organization?

Mr. DI SANTO. Yes, sir.

Mr. NEAL. Would you mind giving us some details, say, as to how you conduct your business, where your sources of income are derived, and so on?

Mr. DI SANTO. I would be happy to. Our organization is, in my opinion, the world's largest weather organization. We operate not only in the United States but, at the present time, we are operating in 13 foreign countries, including Canada and Mexico. Our organization operates in several fields in connection with weather. The oldest part of our organization, which is some 28 years old, is in the business of providing long-range weather forecasts to private industrial corporations throughout the world. That has been our main business for 28 years.

Secondly, we have developed certain instruments such as rain gages, weather guides, weather casters, that we will sell on a private basis.

Third, we have operated for the past 10 years in the field of weather modification as another branch of our activities.

Fourth, we maintain, and insist on maintaining on a research organization, a nonprofit research organization, the American Institute of Aerological Research, which is constantly researching problems on weather.

These are our sources of income, entirely from private enterprise all the way through.

I might say that we have established in Denver, Colo., the world's largest commercial meteorological laboratory. We are now utilizing the Remington Rand Univac 120 for high-speed computation in making long-range forecasts and the progression we have made indicates, and we have told our customers this, and we are doing it, that we will be able to forecast a year or more in advance, fairly accurately as we progress our further researches in this field.

Mr. NEAL. Has your information along those lines always been available to the Government at any time?

Mr. DI SANTO. At any time that a Government agency has requested information from us, we have gone out of our way to volunteer everything they want. I think Captain Orville, of the Advisory Committee on Weather Control, can testify that anything they wanted he gave them.

In one of their projects "Project overseed" they asked us for the loan of our equipment and fuel. We not only gave them the equipment and fuel, but we sent our own man up there to show them how to operate it and conduct it at no cost to the Government whatever. We still are willing to supply any information to the Government that is necessary to the Government. We are not willing to supply information, that may be passed on to our competitors, to the Government. And that is only natural.

Mr. NEAL. May I ask you this one other question? This bill, as I understand it, would provide $1 million a year over a 5-year period. It is largely allocated for research. Now I appreciate very much the emphasis you placed on the development of scientific knowledge and private industry's contributions to that end.

I think that is very commendable.

Now with respect to the appropriated moneys to the National Science Foundation, in your opinion should it be largely devoted to purposes of pure research, basic research, or to what extent would you say that money should be allocated to the various private institutions and colleges for basic research and to field personnel engaged in practical observations?

Mr. DI SANTO. Well, Congressman Neal, to attempt to divide the distribution of $1 million is rather a difficult problem for me; but I can answer it this way, that I think the program needs, first of all, some basic research into the phenomenon that we are not familiar with and certainly that is essential and necessary.

Part of the funds, I think a larger part of the funds should go toward this basic research which is so necessary.

Mr. NEAL. Which naturally means that the basic research laboratories should have it.

Mr. DI SANTO. Basis research is not limited only to the laboratory. There is tremendous basic research that can be done in the field.

For example, one part of it, the study of the distribution of nuclei in the atmosphere, natural nuclei and the effect of additional nuclei in the air, this is a field basic research job which is not done in the laboratory at all. It is done right out in the field. You fly up into the clouds and you take samples of the nuclei and you take counts, you analyze their composition, and you then release additional silver iodide or other nuclei into the atmosphere and determine what happens.

Even the study of the mechanisms of developing rain drops is a job that can be best done out in the field where you are studying right with nature.

When you create laboratory conditions, it is a good thing. I am not criticizing it.

But there is no comparison with the creation of a simulated laboratory situation with this tremendous laboratory outside, which is the biggest laboratory on the face of the earth and that is the laboratory we should be using; so we do want to get away from strictly laboratory research.

It is true we need laboratory research, but we also need field research. You take, for example, I examined the last quarterly report of the National Science Foundation distribution of funds for various researches all over the United States, all over the 48 States, and in this whole report I do not find one commercial organization that had been given any assignment for any research.

It is strictly limited to colleges and universities and societies and meetings and so on.

We have no objection to that. We need this college research and we need these society groups, but there are people in commerce who can contribute a great deal to the researches of this country and they should be given some of the problems to solve. It is the principle of

having a cooperative effort combining all of our knowledge together to solve this problem of weather control.

Mr. NEAL. I take it you assume that a great deal of success for administration of this bill, if it passes, will depend on the ability and the extent to which your advisory committee works harmoniously with the National Science Foundation, is that right?

Mr. DI SANTO. It will depend entirely upon the pulling together by the National Science Foundation, through its committee and all the groups in the United States who are interested in this program and who have developed along these lines, for them to sit down at a table and to work out a program that will solve these problems utilizing all the brains we have instead of just the brains of one Government agency, not that I minimize them.

But what are you going to do when the head of a Bureau calls all of the people who have been in this program for the past 7 years, who are just amateurs and misrepresented operators. What competence can we have? Yet when the final report is drawn and the projects evaluated, the projects evaluated were the projects evaluated by these so-called hit-and-miss amateurs.

I give you one other example, Mr. Neal. I will read to you from the advisory committee report from a statement by Herbert C. Tom to the effect that dry ice seeding has very limited results and is now recognized.

I will read the following:

> The Weather Bureau also conducted an extensive experiment in cloud seeding, using dry ice in the winters of 1952 and 1954 in western Washington State as part of an ACN project.

We sent recommendations in relation to that project asking them to use ground generators as well as air and to use silver iodide as well as dry ice. No attention was paid to it.

Now listen to this:

> The trials were not exclusively on "oreographic clouds" although such clouds * * * the final results of this experiment have not yet been published.

How long do we have to wait, 10 years, before they tell us what happened here? Do we have to wait 10 years for them to write a report on a project that was completed in 1954?

That is the kind of thing [indicating] that I think if we could get together and bring all the brains together and develop projects which would make some sense and we could get reports out now, not 10 years later, we might get somewhere.

Mr. NEAL. Do you think an advisory committee could help bring that about?

Mr. DI SANTO. Yes, sir.

We were very happy to have an advisory committee on weather control because it was not tied to any Government agency. It was a dynamic agency. It set out to do the job with a positive attitude even with the limitations it had. Yet, last year when the bill was originally written, it was written to provide for a continuation of the Advisory Committee on Weather Control.

This committee was taken out of the bill on the ground that it was a temporary committee and that it should be the job that could better be done by a permanent Government agency.

Mr. Chairman, if I were to do it over again, I would recommend that we make the Advisory Committee on Weather Control a permanent agency operating around the same basis as the AEC, then we would get some work done in this field.

We have spent every dollar we have to progress this science and we haven't had any help. We have had a negative attitude instead.

Mr. LOSER. Mr. Chairman, will the gentleman yield?

Mr. NEAL. Yes.

Mr. LOSER. I am wondering what Government agency it is that you are making this assault on?

Mr. DI SANTO. I am not making it on any particular Government agency.

Mr. LOSER. Well, it seems to me that you have just about assaulted them all, from what you have said.

Mr. DI SANTO. There is a situation in Government where one Government agency clears with another Government agency, and that is the way it works.

Now, primarily, the United States Weather Bureau is the key agency in the field of weather.

Mr. LOSER. Are you critical of the Weather Bureau?

Mr. DI SANTO. We certainly are.

Mr. LOSER. What have they done that you did not like?

Mr. DI SANTO. The very things we point out in here.

Mr. LOSER. It says on page 2, your suggestion No. 5, "During the same 10 years many of the Government agencies have taken a negative attitude. They have been conspicuous for their ridicule and unbelief."

Mr. DI SANTO. That is right.

Mr. LOSER. Is that criticism also directed to the National Science Foundation?

Mr. DI SANTO. The National Science Foundation has not taken very many positions until recently.

Mr. LOSER. I asked you if you were critical of the National Science Foundation?

Mr. DI SANTO. No, I am not.

Mr. LOSER. I notice on page 6, suggestion No. 6 of your statement, that you suggest that the Government subsidize certain organizations and groups that are conducting scientific weather modification activities.

Mr. DI SANTO. That is not exactly what we mean, Mr. Loser.

Mr. LOSER. Well you say, "the bill should provide a method of giving financial assistance."

Mr. DI SANTO. Right. That is what I mean.

Mr. LOSER. Can you distinguish between "financial assistance" and "subsidizing"?

Mr. DI SANTO. Yes, I do, very definitely.

Mr. LOSER. How do you do that?

Mr. DI SANTO. In this particular instance, we have certain projects that have peculiar problems in their particular areas. They are conducting weather observations. They need some study in connection with that problem. For example, the hail project in western Nebraska. They should get assistance, we think, financial assistance in the development of a research project in that area to solve some of the peculiar problems for that particular area.

We don't mean for you to subsidize them.

Mr. LOSER. Under your suggestion No. 6, wouldn't that include your corporation?

Mr. DI SANTO. No, sir; it would not.

Mr. LOSER. Are you not carrying on scientific weather modification activities?

Mr. DI SANTO. We are, sir; but we are not asking for our own corporation.

Mr. LOSER. I am not suggesting that you are asking for it, but I am saying that under your suggestion No. 6 you would be eligible for it if the bill contained your No. 6 suggestion.

Mr. DI SANTO. No, because we are not specifying the private commercial operator in weather modification.

Mr. LOSER. But you say "and others who have been or are now conducting scientific weather modification activities."

You are now engaged in that activity?

Mr. DI SANTO. We are as a commercial operator.

Mr. LOSER. And you fall in that category?

Mr. DI SANTO. It was not intended in that way, sir, and it is not intended and if the Congressman desires, we will be glad to strike out and others?

Mr. LOSER. I don't have any objection to it at all, Mr. DiSanto.

Mr. DI SANTO. Well, we do not want any subsidy as a private commercial operator. We do not want any subsidy whatsoever, none at all.

Mr. NEAL. You added a few words to that paragraph, did you not? Didn't you limit it by the words "research only?"

Mr. DI SANTO. That is right. I added those words when I was making my presentation.

Mr. RHODES. Who is responsible that no report was made on this project that was completed in 1954?

Mr. DI SANTO. It lies in the department or bureau who conducted that research job.

Mr. RHODES. Do you know who it is?

Mr. DI SANTO. I think it is the United States Weather Bureau.

Mr. RHODES. Thank you.

STATEMENT OF DAVE GRASMICK, CHAIRMAN, NORTH PLATTE VALLEY HAIL SUPPRESSION, INC., MORRILL, NEBR.

Mr. RHODES. Our next witness is Mr. Davis Grasmick, chairman of the North Platte Valley Hail Suppression, Inc., Morrill, Nebr.

You may proceed.

Mr. GRASMICK. Mr. Chairman and members of this committee:

My name is Dave Grasmick. I am a rancher and stock feeder from Morrill, Nebr. I have just recently been elected chairman of the newly created Nebraska State Weather Control Commission.

In the Nebraska State legislative session of 1957, senate bill 540, was passed which provided for the establishment of a State weather control commission. This law provides that the commission shall consist of the director of the department of agriculture and inspection; the dean of the College of Agriculture, University of Nebraska; the director of conservation and survey divisions of the University of Nebraska; and the chairman of the department of physics of the Uni-

versity of Nebraska; and four representatives of the general public appointed by the Governor.

This commission held its first organizational meeting early in February at which time, I was elected chairman.

The law provides for the licensing and evaluations of weather modification operations in the State of Nebraska. You may be interested in learning that since 1950, there have been five areas with rain-increasing programs and one area with hail-suppression programs in the State of Nebraska.

All of these operations have been carried out on a voluntary basis by raising funds from farm to farm and businessmen. This has all been private financing without State or Federal funds involved.

It is my feeling that additional basic and applied resarch is needed to improve and increase the benefits of these operations. However I wish to urge that the progress and investment that has been made over the, past 10 years in this field should be utilized to the maximum in any research program.

I urge passage of bill S. 86. Also, I would like to submit for your consideration the following suggestions:

1. The National Science Foundation provide a neutral and independent committee to administer the program.
2. The National Science Foundation be advised to utilize the experience and knowledge gained to date by all groups.
3. The National Science Foundation aid and assist the groups engaged in such programs.
4. Field operational research is necessary to increase current benefits.
5. I suggest that the National Science Foundation pay special attention to recommendations made by the National Advisory Committee on Weather Control in its final reports.

With much progress being made in modifying the weather—worldwide—I again urge speedy passage of S. 86.

Gentlemen, I wish to thank you for this opportunity to appear before you.

Mr. RHODES. Thank you, Mr. Grasmick.

STATEMENT OF CLIVE OSTENBERG, CHAMBER OF COMMERCE, SCOTTSBLUFF, NEBR.

Mr. RHODES. Our next witness will be Mr. Clive Ostenberg, Chamber of Commerce, Scottsbluff, Nebr.

You may proceed.

Mr. OSTENBERG. Mr. Chairman and members of this committee. My name is Clive S. Ostenberg, farmer, rancher, and cattle feeder from Scottsbluff, Nebr. I am here before this committee representing the North Platte Valley Associated Chamber of Commerce, and the Scottsbluff Chamber of Commerce.

Before I continue I should like to present to this committee a letter directed to Congressman E. Y. Berry, from Mr. Jack Goodwin, secretary of the Scottsbluff Chamber of Commerce. With your permission and the unanimous approval of this committee, I would like to have this letter included in the record of my testimony.

Mr. RHODES. Without objection, it will be done.

(Letter referred to follows:)

CHAMBER OF COMMERCE,
Scottsbluff, Nebr., March 12, 1958.

Congressman E. Y. BERRY,
House Office Building, Washington, D. C.

DEAR CONGRESSMAN BERRY: It is our understanding the Interior and Insular Affairs Committee of the House will hold hearings on Tuesday, March 18, 1958, on the bill, which you cosponsor, to place weather modification research programs under the National Science Foundation and to appropriate the necessary funds for an adequate operation of same.

If this is correct we again urge you to review the resolution and material sent to you last July relative to the passage of S. 86. We definitely believe this legislation is in the interest of the people of this area, and in fact, the entire country since the eventual control, or modification of weather would be a marvelous addition to our way of life and prove extremely beneficial to all.

We even ask you to consider placing our resolution on record in the Congressional Record, if that would in any way enhance the passage of this bill. We are also sending you sufficient mimeographed copies of this letter to enable you to give copies to each member of the committee.

We wish to point out further that we are in favor of "cutting" Federal expenses in many fields of Government operation, as we have indicated to various committees of the House and Senate, dealing with appropriations and projects we felt could be curtailed. In this case, however, this legislation conceivably could bring about an eventual benefit to the country which would increase the national income and productivity to the end that greater monetary benefits would be received, both by the people and by the government through the increased taxes they would be enabled to pay.

For example, it is claimed by the directors of the Valley Hail Suppression, Inc., elimination of hail damage alone, in 1957, in an area comprising approximately 300 square miles, $4 million in crops was saved. If this is multiplied by the total number of square miles in the United States which are subjected to extensive hail damage, it becomes a tremendous sum. Add to this the potential control of drought control of the snowpack, and the many other weather conditions the research may lead to the control of, and you can see why this program is essential and valuable to the entire country.

Sincerely yours,

A. B. GOODWIN, *Secretary-Manager.*

Mr. OSTENBERG. Also, I have a resolution adopted by the Scottsbluff Chamber of Commerce, a copy of which I would like to distribute to this committee.

It appears possible, in the not too distant future, that weather can be controlled. That famous saying of Mark Twain, "Everybody talks about the weather but nobody does anything about it" no longer is true. In many localities something is being done about it.

We the people in the North Platte Valley of eastern Wyoming and western Nebraska, have been "doing" something about the weather for the past 5 years. We are in an area severely damaged by hail every year. An area rated by hail insurance companies as having such a high incidence of hail that many companies will not even assume the risks of insurance.

These extreme insurance rates were an important factors in influencing the decisions of the farmers of our area when it was suggested that an effort be made to seed the clouds in an attempt to minimize the occurrence of hail.

They, and the businessmen of the valley communities, put their money into a "Valley Hail Suppression, Inc." and hired an airplane to seed the clouds with chemicals believed capable of preventing the formation of hail.

How successful this experiment has been is a matter of individual thinking as no scientific basis of evaluation has as yet been accepted

by the United States Weather Bureau or other governmental agencies and there is not complete agreement among those scientists who are working on weather modifications.

One yardstick, however, that can be used, is the willingness of the people themselves to put their money into this type of program.

In the North Platte Valley of Nebraska, we have voluntarily raised money from farmers, ranchers, and businessmen to carry on a hail suppression project for the past five years. Continuous support has been forthcoming from the same people over that period of time.

This is indicative of their belief in the possibilities of weather modification even though they are aware of the fact that our program here is in the experimental stage.

It is our contention that S. 86 should be adopted with provisions for appropriations as follows:

1. Undertake basic, applied, and engineering research.
2. Establish a committee on weather control by law, in the National Science Foundation, composed of 5 scientific members and 6 lay people none of whom shall represent any governmental agency or commercial operators.
3. Those Federal agencies concerned by this bill to act as technical advisers to the committee.
4. Commercial operators also to serve as technical advisers.
5. The National Science Foundation and this committee to provide financial assistance to organized groups which are undertaking their own weather modification projects.

If these provisions are provided, as we think they should be, the Platte Valley Associated Chamber of Commerce believes our location and past interest deserve consideration in that the basic and applied research should be in an area that has high incidence of hail, snow, thundershowers, wind, torrential rain, light rain and sunshine.

The North Platte Valley has all of these. Then, too, it should be in the central part of the United States so that weather researchers have access to it from all parts of the Nation. We are so located.

It should have an existing weather modification experiment in operation. We have had such a project for 5 years and will continue to maintain one.

It should have a weather station. We have that.

In addition, the Great Western Sugar Co. has maintained, for 22 years, complete records as to hail and rainfall over the entire area they serve. These records, the most complete in the United States that we know of, are available for analysis and comparison.

All of these factors should weigh heavily in favor of the North Platte Valley region, but in addition to these, there are other factors to be considered. We have one of the finest airports in the country from which to send up planes, balloons and to take sightings. We have a smog free air with little or no smoke haze. We have good schools, rated the best in Nebraska for the children of staff people to attend.

We have access to recreation areas of the best. The Black Hills of South Dakota, Yellowstone Park, Estes Park, Teton Park are but a few of the recreational areas which are less than a day's drive from here.

We have, on the whole, a pleasant climate in which to live. A 4,000-foot altitude gives cool nights in summer without air conditioning and

warm, but not hot, days. Winters are cold, but as our climatic data proves, we do not have excessive heat or cold, yet have sufficient variation to be healthful and invigorating.

So, in our minds, this area is admirably situated to have such a research program located at the Scottsbluff Municipal Airport where already are located the weather bureau, CAA office, and the headquarters of the weather modification concern employed by the Valley Hail Suppression, Inc.

Resolutions favoring such a location of this research, if created, have been passed by the North Platte Valley Associated Chambers of Commerce and the Scottsbluff Chamber of Commerce. The people of this region will appreciate your consideration of their desires to have it located here.

Thank you.

Mr. RHODES. Thank you very much.

Any questions?

Mr. LOSER. I would like to compliment the chamber of commerce on having this man as a representative come down here and testify before this committee.

Mr. OSTENBERG. Thank you very much.

STATEMENT OF BOYD QUATE, PRESIDENT, WEATHER ENGINEERS, INC., SACRAMENTO, CALIF.

Mr. RHODES. Our next witness is Mr. Boyd Quate, president of Weather Engineers, Inc., Sacramento, Calif.

Mr. QUATE. Mr. Chairman and members of this committee, my name is Boyd E. Quate. I am president of Weather Engineers, Inc., of Sacramento, Calif. We are a private concern, engaged in the business of conducting weather modification operations and we specialize in hail suppression operations.

Gentlemen, the economic losses suffered by nearly all areas of this country as a result of hail is far greater than many people know. Few people realize that in the United States hail is more destructive than tornadoes. More property damage to industrial, residential, and agricultural areas is caused by hail every year than is caused by tornadoes.

In the 10-year period ending in 1953, hail losses of this country averaged in excess of $53 million annually, according to data compiled by the United States Weather Bureau.

Whereas in that same 10-year period, property damage as a result of tornadoes averaged only about $45 million. It is interesting to note that this period includes the recordbreaking tornado year of 1953. This average of tornado caused damage is about 15 percent less than the damage caused by hail.

Also, it is generally agreed that the hundreds of small losses not reported to the United States Weather Bureau together with those for which no estimates of damages can be obtained would materially inrcease the total hail damage figures.

In 1951, the most disastrous hail year on record, losses totaled $75,432,200. Of this crops suffered damage to the extent of nearly $50 million.

No section of the United States is immune to hailstorms. Although they are more frequent and severe in some sections than in others.

The two States of Delaware and Nevada are fortunate in that their hail losses are the lowest of any of the 48 States. No heavily damaging hailstorms have been reported from these two States, but no other State can claim this distinction.

A book entitled: "Hailstorms of the United States" by Snowden D. Flora, and published by the University of Oklahoma Press in 1956, contains some very good data in regard to the hail damage experienced by the different States. I would like to quote from this book, page 10:

States having the greatest hail damage, 1944–53 (includes damage both to crops and to other property, compiled from records of the U. S. Weather Bureau)

	Damage
Kansas	$101, 877, 900
Nebraska	67, 643, 400
Montana	61, 225, 170
Iowa	60, 171, 212
North Dakota	34, 434, 000
Texas	31, 858, 275
North Carolina	31, 715, 516
Colorado	31, 152, 976
Oklahoma	29, 256, 725
Illinois	10, 226, 120
Missouri	9, 377, 450
Minnesota	9, 807, 800
South Dakota	5, 297, 100
Tennessee	4, 542, 000
New Mexico	4, 061, 100
Arkansas	3, 811, 700

These are the 16 States having the worst record. Other States suffer severe damage, too, but not on as vast a scale as the above-mentioned States. Fruit, especially apples, peaches, apricots, grapes, pears and plums are easily damaged even by comparatively small hailstones, which can pit and bruise it enough to make it unfit for market. Fruit is the main item of loss from hail damage in California, Washington, Michigan, New York, Pennsylvania, West Virginia, and Virginia.

Also, I invite your attention to the fact that there isn't a crop grown in this country that doesn't suffer damage from hail. Tobacco is particularly susceptible to hail damage. Its broad leaves, extending almost horizontally, break sharply at the stalk when pounded by hail. The leaf itself is delicate and its value is drastically reduced by even a small amount of puncturing and tearing. Hailstorms, occurring throughout most of the growing season, are a constant menace. Cotton, corn, the cereal grains, are all susceptible to hail damage. Even the trees of our wooded areas of this country suffer when severely damaged by hail.

The most damaging hailstorm of record occurred on June 23, 1951, when the one storm caused damage amounting to $13,240,000. This storm struck the area from Sedgwick County to Allen County in Kansas and included the city of Wichita.

During the period of 1944 through 1953, there were an average of six storms per year that caused damage in excess of $1 million. Some of these heavily damaging hailstorms were reported as far south as Florida and as far north as Michigan, Minnesota, North Dakota, and Montana. Storms causing damage in excess of $1 million per

storm have been reported in California in the west and New England in the northeast.

The largest hailstone that was ever officially measured fell on July 6, 1928, at Potter, Nebr. This stone measured 17 inches in circumference and weighed 24 ounces—one pound and a half. This size may be compared to an ordinary grapefruit, which, if my memory serves me right, measures about 10 inches in circumference.

Even our Nation's Capital, Washington, D. C., has suffered heavy loss on occasion as a result of extra large hailstones. On April 29, 1938, hailstones were reported to be 3 inches in diameter. On May 26, 1953, hailstones were reported ranging in size from golf balls to baseballs.

It is inconceivable to us that the public, both agricultural and industrial, will permit hail losses of this magnitude to occur, if science can do something about it. Also, it is our opinion that not only can science do something about it, but that scientific endeavor, on a relatively small scale is doing something about it.

We invite you to consider that all the hail suppression projects that we know of, have been financed locally by the people themselves. No outside or governmental financial support has ever been given. The people with whom we contract with believe that they themselves should finance their own local hail-suppression operations. The problem is theirs and the results obtained will be theirs and theirs alone, as far as the operations are concerned. However, there seems to be a practical limit to which local areas are able to finance their own programs. It has been possible to obtain finances locally in each area to conduct the physical operations, but it has been impossible to obtain finances locally to conduct any extended basic and applied research program.

Most people to whom I have talked seem to believe that it is the responsibility of the local groups to finance their own field operations where they themselves obtain all the benefits. However, for those programs where information must be obtained and where this information will be of benefit to the Nation as a whole, it should be the responsibility of all the people, and should be financed by Federal funds.

We would like to state our support of S. 86 and make the following recommendations: This new science is of such vast importance, both economically and otherwise, to the Nation as a whole, that we believe that the supervision of any research program Congress decides upon should be a full-time job. We recommend that a committee of responsible persons be given complete authority for any and all research programs relating to weather modification and financed by Federal funds. We agree that this committee could serve under the Director of the National Science Foundation, but the Committee members should have no other governmental connection. Their functions will be too important to the Nation as a whole to be doing only a part-time halfway job.

We would also like to recommend that Congress recognize the need for two types of research in this new field. We desperately need more extended basic laboratory research. But also, of equal importance, applied research in the field is needed. We do not believe that the progress will be achieved, and of which the scientists of this

great country of ours are capable of producing, if one type of research is neglected at the expense of the other. Both laboratory and field research is urgently needed.

May I invite your attention to the fact that our good neighbors to the north—Canada—have carried out hail suppression operations for the past 2 years and are now going into the third year. The Canadian Government has appropriated $100,000 each year for a radar research program alone to observe and study the hail suppression operations. We think this is a most commendable action.

In closing, I would like to say that we believe we are making progress in this new science of weather modification, but the Nation needs favorable congressional action for the type of research discussed before this committee today to develop and continue world leadership in this exciting new scientific field.

Gentlemen, it has been an honor to appear before you today.

Thank you.

Mr. RHODES. Thank you, Mr. Quate.

STATEMENT OF WALTER G. SCHREIBER, PRESIDENT, HUDSON VALLEY CROP SERVICES CO-OP, INC., RED HOOK, N. Y.

Mr. RHODES. Our next witness is Mr. Walter G. Schreiber, Hudson Valley Crop Services Co-op, Inc., Red Hook, N. Y.

You may proceed, Mr. Schreiber.

Mr. SCHREIBER. I would like to read into the record two prepared statements, if I may.

I am Walter J. Schreiber, president of Hudson Valley Crop Services Co-op, Inc., which is engaged in a hail prevention program in our valley.

I am also a farmer, primarily a farmer, since I make my living at it or I try to.

During the past 10-year period, since the laboratory experiments in atmospheric physics were conducted by Drs. Langmuir, Schaefer, and Vonnegut at the G. E. Research Laboratory in Schenectady, weather modification techniques have improved and results point to future possibilities of tremendous impact. At least 40 other countries, including Australia, Japan, Switzerland, Russia, Spain, Israel, and Pakistan, have recently or are presently conducting research using the scientific methods proposed by Drs. Langmuir and Schaefer.

In the spring of 1956, subsequent to a year of disastrous hail damage to the crops of the Hudson Valley in New York, a group of men representing some 400 growers in the area met and formed the Hudson Valley Crop Services Co-op, Inc. The purpose of this group was to determine the extent to which hailstorms might be suppressed through weather modification techniques.

A commercial weather modification company was contacted (Weather Modification Co., San Jose, Calif.) and during the summer of that year a field operation was put into action covering a 1,500-square-mile area. The results of the 1956 program looked extremely impressive but not necessarily conclusive. The program was renewed for the following summer of 1957. While this operation was successful on all storms similar to those of the previous season, it resulted in only partial suppression of several high-intensity hailstorms, and

damage to crops was termed excessive. The need for further research, particularly on severe intensity storms, was graphically demonstrated.

The programs covering the 2-year period were financed mainly through voluntary contributions from the growers in the area and in part by donations from business houses. The sincere interest of the growers concerning a serious economic problem is emphasized by the fact that more than $70,000 was voluntarily contributed for these programs.

The need for a continuation of hail suppression work in the Hudson Vaalley is emphasized in two broad fields: (1) the economy of the Hudson Valley and the entire State of New York; (2) the value of resultant information to the entire field of weather modification and indirectly on the overall economy of the United States.

As to the effect on the economy of the Hudson Valley, it should be emphasized that this area alone produces an average annual crop of about 7 million boxes of apples. The value of this varies greatly with marketing problems, but would average between $15 million and $20 million. During the summer of 1957, loss from hail damage to fruit alone was nearly $2 million. Damage to other crops, buildings, and, indirectly, to the entire area was undoubtedly great and produced huge losses impossible to evaluate.

It is important to note that information gained from further programs in the Hudson Valley would be of tremendous benefit to the science of weather modification and result in information usable by other areas throughout the United States. Hail damage throughout the United States, as well as the Hudson Valley, indicates the growing need for further research in this particular phase of weather modification.

There is a great desire on the part of the growers in the Hudson Valley to continue a hail-suppression program, and much serious thinking has been done concerning the future of such a program. However, it does not seem likely that a program designed to answer many of the questions involved in hail suppression can, in the near future, continue to be supported entirely by the voluntary contributions from the growers of the valley.

The experience of 1957 indicates that further research in weather modification is needed. It would require a long-range program to determine the commercial feasibility of hail suppression as one important phase of weather modification, and require funds which the farmers of this area are in no position to spend. The fruitgrowers feel that we wish to pay for our own protective programs, but more knowledge is needed before we can invest $3 to $6 per acre for hail suppression. We would like to be sure that our money will not be wasted. We and other farmers all over the country need to know whether such a program will be economically sound. We seem to have enough, or let's call it adequate, statistical knowledge on weather modification.

This knowledge now needs to be used on an actual rather than on a theoretical basis so that we may have confidence in the commercial application of the ensuing results.

We feel that the proposed legislation allows this opportunity to the National Science Foundation. For such exploration, the Hudson Valley Crop Services Cooperatives, Inc., strongly recommends the enactment of bill S. 86 by this Congress.

Now, I have a further paper which I would like to read here, a statement by Mr. Ralph Smith, who is the president of the New York State Horticulture Society in Rochester, N. Y.

Mr. DINGELL. I wonder if it wouldn't be proper to just have that inserted in the record, because we have so many other witnesses that we would like to have testify for the record. Would you mind just inserting that?

Mr. SCHREIBER. I am satisfied to do that.

Mr. Chairman, I would just like to make one more comment, if I may.

The suggestions that were made by Captain Orville in regard to the four suggested changes in the bill, particularly paragraph 6 of his testimony, which he gave this morning, I would like to endorse that as well as alining myself with Representative McGovern in his statement this morning as regards applied research.

I feel that it is most necessary that we continue, or at least start, to give it a good start, this applied research, and I believe there was other testimony given this morning which we farmers in the valley certainly support. We believe that basic research can lead to a lot of paperwork which will not necessarily manifest itself for years to come, and we believe that field operations as they develop can be immediately applied, and the farmers in this instance would get immediate effect from such a program.

That is the statement I wish to make.

(The statement referred to follows:)

TESTIMONY BY NEW YORK STATE HORTICULTURAL SOCIETY, ROCHESTER, N. Y., RE S. 86, 85TH CONGRESS

DEAR MR. CHAIRMAN: The years of 1956 and 1957 brought to our attention the tremendous importance of weather modification. This impression was created by the hail-suppression project which was then being conducted in the Hudson Valley of New York. Heretofore, to use a cliché, everyone talked about the weather but no one did anything much about it.

It must be obvious to the most skeptical that, if the severity of most of the weather phenomena can be reduced, we will have made tremendous strides toward improvement of our agricultural economy. It must also be obvious that such results are not confined to the benefit of agriculture alone, but also will wield a widespread influence upon the life and economy of our Nation. As our population density increases and as we become more and more mechanized, so will the importance of weather manifest itself. Judging by the results of the Hudson Valley project, and also other projects, we are not sure that it will ever be feasible for man to control weather; but we do not know that the efforts made by the valley fruitgrowers were, at least to a great degree, successful.

Ever since the discoveries of Drs. Langmuir and Schafer we have seen in this country a development of commercial enterprises operating primarily in the field of agriculture, which claim to be able to modify the weather to the satisfaction of their clients. But we claim here that a case only approaching satisfaction has yet to come to our attention. Most programs—particularly those dealing with hail suppression—are short lived. Let us hasten to say here that most companies now operating in this field are doing their conscientious best to do a good job, but with only partial results.

It is our considered opinion that, with the meteorological data now available, programs should be set up—as can be done here in the Hudson Valley—where this knowledge may be applied on a practical basis and where research teams can further develop techniques which can be used by the commercial companies. In this manner we will have actual applied research and still plenty of room for the basic research yet so sorely needed. We believe that, if such practical programs are carried out, farmers and industry will have more confidence in the operations of the weather-modification companies.

The farmers of this Nation cannot underwrite such research. We feel that this is a job for the Federal Government to develop and pass into the hands of farmers and industry so that they may spend their money with confidence.

You have before you bill S. 86, which, in our mind, will provide for the necessary research. We feel, however, that—commendable as this legislation is—we would like to have seen it written with a more positive tone. But, since it is going to be administered by the National Science Foundation, we place our hope and faith in the hands of this able institution. We, therefore, strongly recommend the adoption of this bill at the earliest possible moment.

RALPH R. SMITH, *President.*

Mr. RHODES. Thank you very much.

Those who are listed to testify today and have not answered my call will be permitted to submit their statements for the record. Without objection statements by Mr. Langfitt, Mr. Swackhamer, and Mr. Whitfield will be included.

Our next witness will be Mr. Vonnegut.

STATEMENT OF BERNARD VONNEGUT, ARTHUR D. LITTLE, INC., CAMBRIDGE, MASS.

Mr. RHODES. You may proceed, Mr. Vonnegut.

Mr. VONNEGUT. My name is Bernard Vonnegut. I am a scientist associated with Arthur D. Little, Inc., of Cambridge, Mass.

The development of effective methods for controlling weather would be of such enormous value we cannot afford not to pursue this goal. Therefore, I am wholeheartedly in favor of the intent of Senate bill 86. However, it appears to me as a scientist engaged in weather research that the bill in its present form will largely fail to achieve its desired results because it is based on a false premise.

This false premise is incorporated in the title of the bill—the mistaken assumption that it is possible to define and recognize some kinds of research that may lead to weather control and other kinds which will probably not. I feel there is substantial agreement among my scientific colleagues that the first step that must be taken toward weather control is to enlarge our present very fragmentary understanding of how nature makes weather. Only when we understand this will there be any real chance of our controlling the weather.

I believe we should profit from our past experience. There is little doubt that the greatest step that has been made thus far toward controlling weather was Vincent Schaefer's discovery of cloud seeding. It is worth noting that the experiments leading to this discovery were motivated by no thought of controlling weather but rather the desire to understand how nature works. I feel we should recognize, as the late Irving Langmuir once stated, that we cannot plan research but only provide a favorable climate for it. I believe the best way to achieve weather control will be to sponsor basic research in the physical sciences necessary to the understanding of weather.

I have brought with me a suggestion or a document containing recommendations for a national institute for atmospheric research to be submitted to the Advisory Committee on Weather Control. I would like to have that, if I may, included in the record.

Mr. RHODES. Without objection it will be placed in the record.

(The statement referred to follows:)

Recommendations for a National Institute for Atmospheric Research

By B. Vonnegut and Vincent Schaefer

The importance of weather to our national well-being can scarcely be overestimated. It plays a vital part in our day-to-day personal lives, in our national economy, and in all military operations. The weather is one of the greatest of all the imponderables we face. There appear to be two primary ways that we can cope with the problems posed by the weather. First, we can learn to predict the weather so that we can prepare for it, and second we can learn to control the weather to produce desirable conditions. If we are to predict or control the weather, we must understand far more about it than we do at present. There are large areas of ignorance in the field of atmospheric physics that must be explored before we can make accurate predictions of the weather or control it.

In view of the importance of the weather to our welfare, it is desirable that as a matter of national policy we encourage and promote research in this field on a scale commensurate with its importance. A rough measure of the extent of our present attack on the problems of atmospheric physics can be obtained by comparing the expenditures for research in this field with the annual total national expenditure for research. By rough estimate, we are now devoting less than 0.5 percent of our total research effort toward one of our most pressing problems—the weather. It appears obvious, in view of how important the weather is and how little we know about it, that the present effort is far too small and should be increased.

The establishment of an adequate national program in the field of atmospheric physics will require the following:

1. Competent and imaginative scientific personnel.
2. Financial support.
3. Sound scientific direction and coordination.
4. A flexible organization framework under which the work can be planned and carried out on a long-term basis.

In order to achieve these ends it is urged that the Federal Government take immediate steps to establish an adequate research program in the field of atmospheric physics.

A national institute for atmospheric research should be established. This institute should have the following functions:

1. Have a small permanent force of highly competent research scientists capable of initiating, coordinating, and participating in field and laboratory investigations related to the physics and chemistry of atmospheric processes. From time to time this group should sponsor special field research projects, inviting other research groups to participate in a joint attack on specific problems in basic research.
2. Sponsor research projects in universities, foundations, and private organizations.
3. Select certain local geographic areas for intensive investigations of atmospheric phenomena. These places would be located on the basis of their unique physical features for producing certain effects bearing on important atmospheric problems.
4. Serve as a center for coordinating research in atmospheric physics and chemistry.
5. Encourage the recruiting of capable workers by short-term research studies in existing observatories and other institutions by professors of other disciplines available on sabbatical leave. Proper activity in this category will direct the public's attention to this fascinating and important scientific frontier and thus lead to greater interest on the part of young people toward a career in this field of research.

Because of the complexity of atmospheric phenomena, it is important that the proposed institute have a broad background in the fundamental physical sciences. It is suggested that the overall direction of the institute be in the hands of a board of directors chosen from top-level scientists from many fields, such as physics, chemistry, aerodynamics, biology, and meteorology. These directors will establish policy and appoint a full-time scientific director of the institute. The directors by reason of their diverse interests will insure a well-rounded approach that will cut across the artificial barriers that frequently separate areas of scientific research.

It appears that at the present time the most pressing need is for fundamental knowledge of atmospheric physics and chemistry. Accordingly, it is urged

that the proposed institute be entirely a scientific research organization. It should be unencumbered by other responsibilities, such as weather forecasting, equipment evaluation, or formulating legislative recommendations. It should be the purpose of the institute solely to determine how natural atmospheric processes operate, how they can be predicted, and how they can be modified. The information obtained by this purely scientific group will serve as the necessary foundation for making decisions concerning such practical problems as the possible need for weather-control legislation.

It is by no means intended that the proposed institute would in any way supplant existing work in cloud physics. It would rather be its purpose to aid and stimulate further work in this field and to draw attention to important problems.

Mr. Vonnegut, your statement is a very valuable contribution to support your position.

Mr. DINGELL. May I be permitted to ask Mr. Vonnegut a few questions?

Mr. RHODES. Proceed.

Mr. DINGELL. I was interested in your statement that you urge more basic research and not field operations.

Mr. VONNEGUT. I think much can be learned by field operations, I mean going out and trying, without fully understanding what is going on; but I think there is general agreement amongst scientists that in order to understand what we are doing, and even to be able to do it again, we have to know an awful lot more than we do now. I think our understanding of just what a cloud is, for example, how the air moves in it and how precipitation forms, that this is in terrible shape. In many ways it is as though we were trying to design a supersonic aircraft and just hoping that we would hit upon it without making it necessary to understand, we will say, dynamics or aerodynamics. I think there is certainly room for a more knowledgeable approach and there is a vast foundation that needs to be constructed and this will require continuing work.

In other words, you cannot have a technology of weather control that is independent of any science. In other words, you have to have the science first.

Mr. DINGELL. Would you indicate who Arthur D. Little is?

Mr. VONNEGUT. Yes. Arthur D. Little, Inc., is a firm, a profitmaking organization that engages in a wide variety of different sorts of research efforts for industry and for the Government, too.

Mr. DINGELL. Would you also tell me your educational background, sir.

Mr. VONNEGUT. I am a physical chemist at the Massachusetts Institute of Technology and I received my doctor's degree in physical chemistry in 1939.

Mr. DINGELL. Thank you, sir.

Mr. RHODES. Dr. Wallace E. Howell? Since he is not here they will be permitted to file a statement.

That also includes Dr. James H. Jensen and Dr. Svarre Pettersen and Dr. Glenn E. Stout.

That will conclude the committee hearing. The committee is adjourned.

(The statements which were received are as follows:)

IOWA STATE COLLEGE OF AGRICULTURE AND MECHANIC ARTS,
Ames, Iowa, March 12, 1958.

HOUSE OF REPRESENTATIVES,
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
SUBCOMMITTEE ON HEALTH AND SCIENCE,
House Office Building, Washington, D. C.

GENTLEMEN: Iowa State College would like to go on record as favoring the enactment of S. 86, to provide for research in weather modification.

It is expected that the research program established by this bill would provide a final authoritative answer to very important questions: Can man modify weather in such a manner as to increase or decrease precipitation, suppress hail and lightning, and alter other detrimental weather conditions? If man is able to influence his climate, even on a small scale, it would have a stabilizing effect on the economy of the agricultural and industrial areas of the United States by providing for a more constant water supply.

The research program to be established by the bill is to continue basic research in the field of cloud phsyics and to study natural rain-producing mechanisms in various climatic areas and the effect of weather-modification techniques on these processes. It is important that these mechanisms be studied in areas where no orographic effect is present. Only a properly controlled, carefully designed field experiment conducted over a period of several years will give a definitive answer to what extent precipitation amounts can be modified.

This and other governmental supported programs in weather modification should be carefully coordinated to avoid duplication and to insure that all phases of the program are studied.

Iowa State College would be a willing participant in such a research program.

It will not send a witness to testify before the subcommittee, but this statement presents our opinion for the bill.

Sincerely yours,

JAMES H. JENSEN, *Provost.*

A STATEMENT FOR THE SUBCOMMITTEE ON HEALTH AND SCIENCE OF THE COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE OF THE HOUSE OF REPRESENTATIVES RELATIVE TO S. 86

My name is Glenn E. Stout. I am head of the meteorology section of the Illinois State water survey, Department of Registration and Education, State of Illinois, whose activities are authorized by the board of natural resources and conservation. The water survey which has been in continuous service for 63 years, is responsible for the collection, analysis, and dissemination of facts, concerning water resources in the State of Illinois.

I desire to endorse S. 86, a bill to provide for research in weather modification which was introduced in the 85th Congress and subsequently, amended. It is gratifying to note that the revised bill calls for support of a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, and other weather phenomena.

We are extremely interested in this bill since the weather hazards previously mentioned here occurred with great frequency throughout the Middle West with enormous economic losses resulting from them. It has not always been possible to forecast successfully the occurrences of severe weather due to lack of basic knowledge. Weather modification cannot be efficiently accomplished unless the physical processes are understood. The recent television showing of The Unchained Goddess is an excellent example illustrating some of the forces involved in the production of great storm masses concerning which our knowledge is not complete.

The population density in Illinois and its neighboring States is three times greater than in the Great Plains States. Statistics up to 1950 show that although Illinois ranked 12th in frequency of occurrence of tornadoes, it was first in number of people killed and second in property damage. Thus, the probability of loss of life from tornadoes and other weather extremes is exceptionally high in our State. It is important to design research activities that are applicable to areas of high population and industrial concentration.

United States Weather Bureau records for Illinois during the past 8 years indicate that each year property and crop damages have exceeded $7½ million, excluding flood damage. During 1957 losses from weather phenomena, including

floods, exceeded $43 million. Floods of June 14–15, 1957, in the East St. Louis area and eastward across Illinois caused losses of over $26 million. Records of the Crop-Hail Insurance Association indicate that damage to crops amount to over $1 million each year. In a storm on August 17, 1948, total damage from hail was estimated at over $4 million. These figures for Illinois are only a few that could be quoted to illustrate the magnitude of losses. Yet, only a few dollars are being spent annually on research to understand the initiation and behavior of such storms. One cannot modify the weather until the basic parameters causing it are understood.

HISTORY

Extensive cloud-modification studies began just a decade ago and much credit should be extended to Dr. Langmier, Dr. Schaeffer, and their staff at the General Electric Co. for their findings. Subsequent major projects of the Department of Defense, University of Chicago, New York University, and other organizations have indicated that clouds can be modified, but such studies in the Middle West were handicapped by drought conditions and inadequate aircraft. Consequently, it was not possible to collect sufficient data to accurately define the probabilities of modifying cloud structures and the economical significance of such modification.

In 1948 the State of Illinois recognized the importance of determining the natural conditions of cloud formation and rainfall. Dr. A. M. Buswell, then chief of the Illinois State water survey, presented testimony on House bill 4582 of the 80th Congress which encouraged the use of Federal funds for weather-control studies. A small staff was then organized at the State water survey to develop an understanding of meteorological phenomena pertinent to water resources. Work was initiated to evaluate the progress being made on cloud physics research and dense rain gage networks were established to obtain detailed data on Illinois rainfall. Since that time, considerable knowledge has been gained on the distribution of precipitation and on future research needs.

Through support from the United States Army Signal Engineering Laboratories and the Cambridge Air Force Research Center, a staff of 15 scientists has been engaged by the water survey since 1954 on numerous meteorological studies. The reduction in research funds of the Department of Defense in the summer of 1957 has caused the survey to reduce its meteorological staff by 40 percent.

A few other States, notably Arizona and California, have initiated research programs in cloud physics and cloud seeding. In these few studies financial resources have been limited, and more intensive basic research is needed to expand our knowledge of atmospheric conditions controlling the precipitation process.

BASIC RESEARCH NEEDS

An evaluation of the various studies mentioned in the previous section indicates further research in the fundamentals of cloud physics needs to be undertaken. The known and unknown facts about clouds and rainmaking were summarized in February 1957 by Dr. H. R. Byers, director of cloud physics research, the University of Chicago, in a pamphlet entitled "Cloud Physics and Rainmaking." This pamphlet is recommended for your reading since it has been prepared in nontechnical language for personnel of public utilities, agricultural groups, Government agencies, and others interested in the current status of modifying the weather.

Experiments by the University of Chicago cloud physics project, under sponsorship by the Air Force during 1952–54, and in which the water survey was a subcontractor, indicated that the formation of precipitation in Illinois and much of the Midwest in the summer is frequently initiated by the coalescence process before clouds build to the freezing level. This development in theory is contrary to the general accepted ideas of rain formation by the ice crystal process above the freezing level in this region and is pertinent to cloud modification. The data were quite limited and this work should be continued.

Concurrent with studies on the formation and growth of raindrops, research on the basic physical and dynamical properties in the formation of lightning, hail and tornadoes should be pursued. Detailed field data to determine the characteristics of such storms needs to be collected. The atmosphere needs to be sampled prior to, during, and after the occurrence of these events to ascertain the basic causes for their formation and dissipation. After the natural phe-

nomena are understood, methods to suppress violent storms should be investigated.

REGIONAL INVESTIGATION NEEDS

Studies also made by the University of Chicago indicate a large variation in the cloud dimension characteristics between the Caribbean area, Central United States, and Southwestern United States. In view of the large differences between various geographical regions, it is apparent that cloud physics studies should be undertaken in various parts of the United States.

Droughts occur in all parts of the United States. They are not confined to the arid Southwest or the Great Plains. Deficient rainfall in the Northeast in the late forties caused water restrictions in New York City. Although rainfall in Illinois is often classified as abundant, droughts are not unusual. While a severe drought prevailed in the Southwest part of the United States during 1952–55, the southern half of Illinois experienced a similar drought which caused a crop failure in 1 year, substantial reduction in yield during the other 2 years, and critical shortages in numerous industrial and municipal water systems. A detailed study by the water survey shows that 50 percent of the southern Illinois communities, depending upon surface water supplies, suffered shortages during the 1952–55 drought, and over 10 percent of the public water supplies in the drought region, relying on ground water sources, experienced deficiencies.

Droughts of the early fifties in many regions of the country were followed by major floods on the east coast and west coast. In 1957 floods and wet weather prevailed in the Central and Southeast parts of the country while New England experienced a prolonged drought. The frequency of occurrence of unusual storms varies considerably from one region to another. Consequently, numerous regional studies need to be made. Because of the great variety of climatic conditions in the United States and the complexities of weather, research will be costly.

BENEFITS

The benefits that would be gained by further research in the field of weather modification are numerous. Almost every activity in the United States depends at one time or another upon satisfactory weather conditions. Industry, commerce, agriculture, athletics, and many other activities are confronted with great losses under abnormal weather conditions.

ADMINISTRATION OF RESEARCH

Solving the mysteries of nature is difficult and time consuming. Laboratory models of atmospheric processes have not been built to any great extent because it is hard to reproduce the great complexity of the atmosphere in the laboratory. Studies, laboratory testing, and field experiments need to be designed with great care. Results from meteorological research should not be expected too rapidly. Long-term planning needs to be employed. Capable leadership, sufficient coordination between various groups, and freedom of the scientist to explore ideas are necessary. The National Science Foundation should take the leadership and the Congress should support their request for funds. The millions of dollars spent on research will eventually be compensated for, through reduction in the loss of life, crops, and property damage.

SUMMARY

I wish to heartily endorse the passage of S. 86 and the appropriation of sufficient funds so that study, research, and evaluation in the field of weather modification may be increased considerably.

It appears that present effort in meteorology has been reduced recently due to new programing of some agencies and the general lack of funds for meteorological research.

The benefits of being able to modify the weather are numerous. Before man conquers space, he should learn about his own environment if he wishes to modify it to the best advantage.

STATEMENT OF CHARLES A. O'HANLON, PRESIDENT, WEATHER MODIFICATION CO., MUNICIPAL AIRPORT, SAN JOSE, CALIF., RE S. 86, A BILL TO PROVIDE FOR RESEARCH IN WEATHER MODIFICATION

Mr. Chairman and members of the committee, I was unable to appear before you during the time of public hearings on bill S. 86 because of speaking engage-

ments in South Carolina. If it is still possible to give consideration to this statement I will greatly appreciate it.

In my opinion the science of weather modification will at some time in the future develop to the point where man will be able to control or greatly modify weather. If this is true, then the further development of this science will have the greatest effect upon our economy, our health, happiness, and lives.

It is, therefore, my opinion that continued research in weather modification is of the utmost importance to the people of our country and that such a research program should be started as soon as possible and continued over whatever period is necessary to develop the answers needed. I feel funds should be made available so that a carefully planned and directed program of research can be set up to continue over a period of several years without fear of the possibility that funds will not be provided in future years.

Such a program should be designed and directed by scientists qualified in the fields of atmospheric physics, meteorology, and chemistry. Such a program should include both basic and applied research. It should include both laboratory and fieldwork.

I feel there is a possible danger of spending years in basic research only, duplicating work already done and ignoring the development that has already been made by scientists in private life and by companies now engaged in weather modification.

It is my opinion that field research programs should be set up in several different areas throughout the country simultaneously to speed up our gaining knowledge under all different climatic conditions.

There seems to be a tendency on the part of some groups to want the Government to finance their individual cloud-seeding programs. I think it would be a mistake to use funds provided under this bill for this purpose. This money should be used for research only. I am, however, in favor of a controlled research program being operated in conjunction with an already established cloud-seeding project where such project or projects will have the necessary meteorological conditions required for the research program. Since these commercial projects already have personnel and equipment this should result in a saving to the Government. Under such an arrangement the group sponsoring such projects would pay for the portion of the program which gives benefit to them only and the Government would pay for the research portion of the program which would be of general benefit.

In view of the above I respectfully submit the following suggestions.

1. That the National Science Foundation be directed to establish a special committee to direct the research program. This committee to be made up of qualified scientists in private life and should include some lay members.
2. That this committee hold hearings from all interested parties before the design of the research program so that those fields of research most needed now may be undertaken.
3. That the development already made by private scientists and operating companies be given careful consideration to prevent duplication of efforts.
4. That the program be designed to include both basic and applied research.
5. That consideration be given to combining some phases of the program with already existing cloud-seeding projects.
6. That funds be made available to provide for a long-range research program.

With the above suggestions incorporated in either the bill or the instructions of this committee which will accompany the bill, I recommend passage of Senate bill 86 as soon as possible.

THE CITY OF OKLAHOMA CITY,
Oklahoma City, Okla., March 14, 1958.

Hon. CLAIR ENGLE,
Congressman from California, House Office Building,
Washington, D. C.

DEAR CONGRESSMAN ENGLE: It has come to my attention that there will be a hearing on March 18 to consider S. 86, a bill to provide funds for weather modification research.

I should like to have the privilege of commenting on the present bill passed by the Senate in that it provides that funds appropriated by Congress will be allocated by the National Science Foundation. I would strongly urge that we add a joint committee of scientists and laymen, to be charged with the duty of advising and working with the National Science Foundation, on the allocation of such funds, as well as administering them.

I have had several years of experience on weather modification, and we have had three highly successful contracts with private enterprise, therefore feel that a great deal of money can be saved, and more progress made if Congress provides an advisory committee to help on the program, primarily for the purpose of taking advantage of the research already made by private enterprise, and the vast amount of experience many of these companies have accumulated to the benefit of weather modification. I would certainly have no objection to the Government agencies having representatives serving as technical assistants, and likewise private operators should be permitted to serve as technical assistants.

We are always in need of weather modification in one form or another, and the drought has emphasized one phase of this program.

If Congress would make funds available for basic research, it would, in my opinion, be making a great contribution to the people of the United States, and I wholeheartedly support this program.

Yours very truly,

MORRISON B. CUNNINGHAM,
Director of Public Works.

BAYSIDE, N. Y., *March 14, 1958.*

Hon. OREN HARRIS,
Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D. C.

DEAR SIR: This will acknowledge with appreciation notice of public hearings on S. 86, to provide for research in weather modification.

I regret that I will probably not be able to attend the hearings, but would like to support the proposal for more research in weather, although I am not familiar with the provisions of S. 86. The American Meteorological Society, of which I am a past president, has issued a statement on weather modification, the last paragraph of which states as follows:

"All cloud-seeding operations should be considered as experiments, since the techniques are still under development and there is no sound basis for the quantitative estimation of the results in advance of the operation. As experiments, they should be designed primarily to yield optimum scientific results. There is good reason to believe that greatly improved returns from cloud seeding will result from a sound experimental approach, and this should be fostered by all concerned."

Weather modification has vast ramifications in all fields of human endeavor. As an airline meteorologist, I know how effective it would be if some practical means of weather modification could be developed merely to modify fog conditions at an airport. In recent years, hundreds of thousands of dollars were spent on FIDO, the fog-dispersal system at Los Angeles International Airport. Unfortunately, the installation was not a success and had to be removed. One of the larger airlines a few years ago on its own conducted some research in fog dispersal by dropping materials into low-lying fog from an airplane. Although some success was achieved, it was not sufficient to warrant routine use of the procedures.

On a type of more severe weather, the United States Weather Bureau reports that, on the average, 212 tornadoes are reported every year, with an average of 219 deaths per year. On March 18, 1925, 740 persons were killed in an outbreak of such storms. At the present time, man can neither suppress the development nor divert the movement of tornadoes, hurricanes, or other severe storms. However, his aspiration to do so is a highly commendable one, even if viewed only from the material and humanitarian point of view; militarily, there are even greater implications. But we will never know whether man can modify the weather if we sit back and do nothing about it. I believe the attempt to find out through more research in weather modification is highly desirable.

In this connection, may I draw attention to an interim report of the Committee on Meteorology to the National Academy of Sciences-National Research Council, Washington, D. C., entitled "Research and Education in Meteorology," dated January 25, 1958. This report, I think, places research in weather modification in its proper perspective in relation to research in all phases of meteorology. That Committee, composed of eminent scientists, states that "it would be an inexcusable distortion of presently available knowledge and a grievous violation of trust for this Committee to seize upon the single issue of weather control to argue for an expansion in the meteorological research effort

in this country. To start a crash program aimed at achieving a significant measure of control over large-scale weather patterns during the next few years is unrealistic in the light of currently available information."

Discussing further this matter, the Committee goes on to state that, "the road that leads from the type of local weather control represented by these (small-scale) results to control of large-scale weather patterns is long and winding, and there very well may be insurmountable roadblocks that would halt the would-be traveler. Of one thing we may be sure: The kind of research required to find out whether or not such roadblocks exist is precisely the kind of fundamental research that is required to satisfy the intellectual and economic arguments advanced earlier. Specifically, before it will be possible to ascertain the extent to which alteration of natural weather processes is possible in any given instance, it will be necessary to be able to state in quantitative terms what would have happened if man had refrained from interference in that instance. * * * Certainly, research on some aspects of weather control is an appropriate part of an expanded research program in meteorology, but to justify the program solely on that ground or to let weather control studies, as such, dominate the program would be unwise."

With this point of view I am in complete agreement. I note also that the Advisory Committee on Weather Control recommends a broad research program in meteorology. And, since this Committee recommends the enactment of S. 86, I support this bill.

Thank you very much for affording me the opportunity of stating my views.

Yours sincerely,

ARTHUR F. MEREWETHER.

DEPARTMENT OF WATER AND SEWERAGE,
CITY OF SHREVEPORT, LA.,
Shreveport, La., March 17, 1958.

Hon. JOHN BELL WILLIAMS,
Chairman of Subcommittee on Health and Science,
House Office Building, Washington, D. C.

DEAR SIR: I have been requested to place before you in writing my views on water resources development as it applies to water supplies, surface or underground, crop cultivation of all nature, such as cotton, corn, sugarcane, peas, hay, and the like, and forestry of all types. Industry of all description takes its toll of available water; consequently, must be accounted for, to say nothing of pasturelands.

The subject matter in this appeal has become the top question of the day; therefore, should be seriously considered as such, and anything that we do now should be based upon the best thoughts obtainable on this matter. Having been directly connected with 3 contracts on weather modification, 1 having to do with the water supply of the city of Shreveport, and the 2 others on crop cultivation contracts. All three contracts were successfully concluded through the cloud-seeding method. Therefore, know the method and results.

Now that I have briefly stated the nature of my connections and the extent of my experience and interest, will proceed to the question proper.

I understand that on March 18, 1958, a hearing on S. 86, a bill to provide funds for weather-modification research, will be conducted by the House of Representatives committee. The Subcommittee on Health and Science, under the Committee on Interstate and Foreign Commerce, room 1334, House Office Building, Washington, D. C., will conduct it, the chairman of which is the Honorable John Bell Williams. S. 86, I understand, has passed the Senate and, after the above committee action, will be introduced in the House of Representatives.

The bill in its present form placed the funds in the hands of the National Science Foundation for distribution, relieving all outside or private enterprise of any say-so whatsoever in the matter; controlling the funds and knowing that this agency has adverse feelings relative to the subject of this particular weather modification will eventually eliminate the now private enterprises that have done so much to furthering this program, to say nothing of the many dollars spent, from the picture, and deprive us, the little fellow, of an opportunity of contracting with these firms on our own. The burden of carrying the cost of this work individually is more than should be placed upon them, as every person living in the area treated will be benefited, whether they pay or not. We are now processing a law asking the State to take over the question of weather modification, paying for same through taxation. Every human benefits by rains.

A very reasonable rate is now available if the State takes it over. If the United States Government takes it over, proper representation from the people should be in on the deal to insure an equitable disposition of these funds, and enlist the private operators' knowledge and experience on a working agreement with the committee to the end of making an effective organization. This is a very important proposition and should be well handled to meet the demands that they will have to meet.

Effective research should by all means be continued, and the knowledge already acquired the last 10 years by private concerns should be taken into consideration and those concerned serve the United States Government to the best advantage possible.

I think that President Eisenhower's Advisory Committee report on weather control should be utilized by whatever group decided upon, because of the valuable information contained therein; however, in any event, let's not delay assistance to those interested in furthering this work. In my particular case, weather modification has meant much, as the work done here helped me solve what could have been disastrous and costly. To the crops and all other kindred phases of life, the excess rains proved a blessing.

Had I had more time prior to the meeting, I could have made arrangements to attend, which, I know, I would have gained much from.

I wish to state that I have no personal interest in any of the firms engaged in this work, but, from the work that has been done here, can see wonderful possibilities. I wish to identify myself as being superintendent-engineer of the Department of Water and Sewerage of the City of Shreveport, La., for the past 41 years and, prior to that, resident engineer for the Shreveport Water Works Co. for 17 years, and am now vice president of the Red River Valley Water Resources Association, which has to do with the work of weather modification of 5 parishes of the State of Louisiana working over some 2 million acres of land. Two contracts of weather modification have been entered into and completed successfully here within the last 3 years. Please don't misconstrue the intent and purpose of this letter to the committee. I am interested in the successful outcome of this work.

Yours very truly,

THOS. L. AMISS.

NEW YORK FARM BUREAU,
Ithaca, N. Y., March 17, 1958.

Re S. 86.

Hon. JOHN BELL WILLIAMS,
Chairman, Subcommittee on Health and Science,
House Committee on Interstate and Foreign Commerce,
House Office Building, Washington, D. C.

DEAR CONGRESSMAN WILLIAMS: I very much regret that New York Farm Bureau will be unable to have a representative present at your hearing March 18 in connection with weather modification. I hope it will be possible for you to make this letter a part of the record, for we are very much interested in weather modification as it relates to agriculture.

Fruitgrowers in the Hudson Valley for 2 years have invested a lot of money in connection with hail suppression and are in need of help on the part of the Federal Government in this regard.

Last year the size of the operation was inadequate to cope with the size of the storm that occurred, and growers suffered serious losses as a result of hail damage. The annual meeting of New York Farm Bureau adopted the following recommendations:

"That the United States Weather Bureau enlist the cooperation of the best scientists available in carrying on basic research aimed at developing a workable and effective means of hail suppression.

"That, since experiments are already underway in the Hudson Valley, these experiments be continued through grower-Weather Bureau cooperation."

It is our understanding that, if the appropriation is made, the work will be done by National Science Foundation, Washington, D. C., and that Dr. Klopsteg, of that organization, will allocate funds for the different projects to be carried on.

We emphasize the importance of sufficient allocation of funds to carry on and expand the studies and work that has already been done in New York State in connection with hail suppression in the Hudson Valley.

Sincerely yours,

E. S. FOSTER, *Executive Secretary.*

SCHENECTADY, N. Y., *March 17, 1958.*

Senator FRANCIS CASE,
Senate Office, Washington, D. C.:

Other commitments prevent attendance at House hearing relative to their version S. 86. My attitude toward bill remains strongly in favor as indicated by my testimony before Senate hearing last year. Strong and positive Federal support of basic research in atmospheric physics, experimental meteorology, and weather modifications as provided in bill is essential. Federal coordination of this research effort by National Science Foundation in long line established by Advisory Committee on Weather Control is essential for orderly and effective progress in this important field. Please indicate my continued support to House committee conducting hearing.

VINCENT J. SCHAEFFER.

SAN ANTONIO, TEX., *March 17, 1958.*

Hon. JOHN BELL WILLIAMS,
House Office Building, Washington, D. C.:

Strongly urge your complete support of Senate bill 86 to provide funds for weather modification research. I hope provision will be made for Air Advisory Committee of non-Government experts on research and meteorology to allocate funds and designate research projects. Much has already been accomplished and advantage should be taken of information and facts now available.

ALBERT K. MITCHELL, *Albert, N. Mex.*

SAN JOSE, CALIF., *March 18, 9581.*

Hon. JOHN BELL WILLIAMS,
Chairman, Interstate and Foreign Commerce,
New House Office Building, Washington, D. C.:

Potential benefits of weather control to entire Nation are immense. Coordinated research program would be invaluable in development of this new science. Therefore respectfully urge favorable committee report on bill S. 86.

WEATHER MODIFICATION CO.

WASHINGTON, *D. C., March 17, 1958.*

Hon. JOHN BELL WILLIAMS,
Chairman, Health and Science Subcommittee,
House Committee on Interstate and Foreign Commerce,
House Office Building, Washington, D. C.:

American Farm Bureau Federation respectfully recommends the approval of S. 86, to authorize a research program in weather modification. Appreciate incorporation this wire in hearing record.

AMERICAN FARM BUREAU FEDERATION,
MATT TRIGGS,
Assistant Legislative Director.

ATLANTA, GA., *March 18, 1958.*

Hon. JOHN BELL WILLIAMS,
Chairman, Subcommittee on Health and Science,
House Office Building, Washington, D. C.:

The Forest Farmers Association, representing owners of 25 million acres of timberland in 15 Southern States, wants to express its continued interest and endorsement of S. 86. We plan to file a written statement similar to Mr. J. V. Whitfield's statement at Senate hearings last year. We generally support the suggestions of the water resources development corporation as presented by Mr. John Di Santo.

FOREST FARMERS ASSOCIATION,
WALTER MYERS,
Executive Director.

FLOYD E. VOLENTINE & SON,
Shreveport, La., March 17, 1958.

Congressman JOHN BELL WILLIAMS,
House Office Building,
Washington, D. C.

DEAR CONGRESSMAN WILLIAMS: I learned today that you will begin hearings on Senate bill 86, March 18, and wish to take this time to make a few comments on the bill.

The Red River Valley Water Resources, Inc., is an organization of farmers in six parishes in northwest Louisiana. We are organized to promote cloud seeding—when necessary, to assist in increasing rainfall. This project has been successful.

We are definitely interested in S. 86 and testified by mail when this was before a Senate committee.

It is our understanding that you are chairman of the subcommittee which will hold hearings on this bill. We urge you to do all you can to represent us at this hearing.

We do not believe that control of this program should be turned over to a governmental bureau, which in all probability would not use the tremendous amount of information and the facts already in the hands of private enterprise and being used successfully by them.

This program, in our opinion, must be properly organized and administered by a nongovernmental committee assisted by some Government agency designated to serve as technical assistants, along with private operators.

I could write a long letter offering our beliefs in regard to this matter, but do not believe it necessary, and will close with this statement.

We believe as a result of experience and of information we have studied, that it is possible to have weather control, not only by local projects but upon a broad scale global weather pattern.

Therefore, we urge you to provide a working body of private enterprise, individual scientists, civil and military bodies of Government to tackle an all-out approach to winning the race of weather control, as well as provide assistance in obtaining weather modification beneficial to agriculture and city people.

Again urging you to represent us at this hearing, I remain,

Sincerely yours,

FLOYD E. VOLENTINE,
President, Red River Valley Water Resources, Inc.

AMERICAN METEOROLOGICAL SOCIETY

BOSTON, MASS.

STATEMENT ON WEATHER MODIFICATION

[Release May 10, 1957]

The council of the American Meteorological Society has assumed the responsibility for issuing periodic statements on the scientific aspects of weather modification and control. Two previous statements were issued in 1951 and 1953. In view of the additional information on this subject that has become available in the interim the council deems it desirable to issue a revised statement of its opinion at this time. The statement on weather modification approved by the society's council at a meeting on April 29, 1957, is as follows:

1. The seeding of supercooled cloud with dry ice will usually convert at least a portion of the cloud to ice crystals. Under appropriate conditions such seeding may release variable amounts of precipitation from fairly deep and active cumulus clouds in which the natural release of precipitation has not already started. Small, inactive cumulus clouds are usually dissipated when they are seeded with dry ice. Holes or valleys may be produced in supercooled layer clouds or supercooled fogs by seeding them with dry ice.

2. The injection of water drops or hygroscopic salt particles into active warm (nonsupercooled) cumulus clouds may release some rain. Small, inactive, warm cumulus may often be partially or completely dissipated by seeding them from above with water drops or other particles; such dissipation may occasionally be accompanied by the release of very light rain.

3. In some cases warm fog and stratus may be dissipated in restricted regions by the use of certain hygroscopic materials.

4. At temperatures below about —5° C., silver iodide crystals are known to affect supercooled clouds in much the same way as dry ice. The frequent absence of clear-cut results following the operation of ground-based silver iodide generators is believed to be due to one or more of the following causes: (*a*) The failure of the seeding material to reach the supercooled clouds; (*b*) the absence of clouds that could be affected by seeding; (*c*) the decay of the silver iodide; (*d*) the presence of an ample supply of natural ice crystals; (*c*) topographical influences which defy quantitative measurement.

5. Cloud seeding acts only to trigger the release of precipitation from existing clouds. The release of substantial amounts of precipitation by either natural or artificial means requires the preexistence of an an extensive moisture supply in the form of moist air currents and of active cloud-forming processes. For this reason the meteorological conditions most favorable for the articficial release of precipitation are very much the same as those which usually lead to the natural release of precipitation. This factor plus the extreme natural variability of precipitation makes the evaluation of the effects of seeding difficult and often inconclusive.

6. Evaluations performed by independent agencies have yielded reasonably convincing evidence of increases of precipitation due to the operation of ground-based silver iodide generators only for operations conducted in cold weather in regions where forced lifting of the air over a mountain range is an important factor. No convincing evidence has been presented which indicates that ground-based silver iodide seeding affects the amount or character of the precipitation over flat country. This does not prove that there are no such effects but suggests that if present they are too small to be detected by statistical analyses of data available to this date.

7. In the absence of a truly quantitative theory of precipitation the best present means for obtaining a quantitative estimate of the effect of seeding on precipitation is through the statistical evaluation of randomized cloud seeding experiments. The randomization is necessary to insure valid interpretation of the results and a long series of such experiments may be necessary to detect small effects.

8. Present knowledge of atmospheric processes offers no real basis for the belief that the weather or climate of a large portion of the country can be significantly modified by cloud seeding. It is not tended to rule out the possibility of large-scale modifications of the weather at some future time, but it is believed that, if possible at all, this will require methods that alter the large scale atmospheric circulations, possibly through changes in the radiation balance.

9. All cloud seeding operations should be considered as experiments since the techniques are still under development and there is no sound basis for the quantitative estimation of the results in advance of the operation. As experiments they should be designed primarily to yield optimum scientific results. There is good reason to believe that improved returns from cloud seeding will result from a sound experimental approach and this should be fostered by all concerned.

The society has adopted a policy of issuing statements, to be reviewed annually on a number of weather problems of vital interest to the public. These include the detection, tracking, and prediction of tornadoes and hurricanes; long-range forecasting; fallout of radioactive debris, and other subjects.

MARCH 10, 1958.

To: Chairman, Subcommittee on Health and Science, House of Representatives Committee on Interstate and Foreign Commerce, room 1334, House Office Building, Washington, D. C.

From: Paul J. Caubin, secretary-treasurer of Water Resources Development Corp., 460 South Broadway, Denver, Colo., a private corporation engaged in worldwide weather modification projects.

Reference: Public hearing on S. 86, to provide for research in weather modification, to be held at 10 a. m., Tuesday, March 18, 1958.

Following are my specific recommendations pertaining to this bill:

1. The program must be properly organized and administered by the establishment of a joint committee of scientists and laymen to work within the National Science Foundation. This committee or board should be composed of nongovernmental individuals and should be given full authority and responsibility to administer the appropriation under this bill.

2. No research under this committee should be designed to "re-do" what is aready known. The work of the private operator should be recognized, as well as the findings of President Eisenhower's Advisory Committee on Weather Control.

3. Basic research should be continued and confined to exploring new potentials.

4. Applied research should be accelerated and private concerns must be a part of this program. The physical and engineering side must be emphasized. This is prevalent in all our developmental history. A good recent example is our missile tests—the final work of design improvement must be done through the actual physical testing—the old trial and error approach. This science is no different. Another 10 years could be lost in the laboratory if we don't face facts.

5. In the apportionment of any funds available under this legislation, consideration should be given—

(*a*) In assisting those groups of individuals that have supported this work over the past 10 years with their own funds.

(*b*) To provide funds for State governors or State agencies to handle such activities within the States.

(*c*) To recognize and assist those private enterprise operators that have struggled unceasingly, against many odds, to progress this science.

(*d*) To set up a working body of private enterprise, individual scientists, and civil and military bodies of government, to tackle an all-out approach to win the race of weather control.

Please accept the following pages as part of my testimony on this matter.

PAUL J. CAUBIN.

My name is Paul J. Caubin and I am secretary-treasurer of the above-mentioned corporation, a private enterprise organization actively engaged in the operation of weather modification programs throughout the world, from initial research and development in 1946, to the first commercial applications in 1950.

I personally attended the recent hearings of your group on this vital subject on May 13, 1957, in Capitol Building, room G–16.

I respectfully urge and request your committee, because of the extreme and far-reaching impact of this bill, to accept and enter this memorandum and appendixes thereto, as a matter of record.

From testimony I heard and have since studied. there are certain misunderstandings and statements of only partial fact that may hinder the clarified rendering of final action.

In addition, I feel it a duty as a private citizen of this great country, to voice an opinion and refer to facts to attempt to prevent the veiling of the economic benefits of weather modification.

Throughout the eons of the history of our world, excluding those military periods, the progress of free democratic countries has been directly tied to the sincere efforts of the individual citizens. It has not been best served by the gargantuan progression of bureaucratic governmental agencies demanding vast sums of tax funds with inherent high percentage factors of duplicity and waste. In addition, such mere existence of agencies demands expansion, regardless of the validity of functions. Also there is the definite tendency of the bureau to render the basic constitutional functions of the Senate and House and the members of such, into the role of servant and not master.

No sincere citizen of any country of democracy desires not to pay the price for freedom and good government—but does desire economy, efficiency of operation and the service to the true aims of such government. Today we can readily see the signs wherein broad bureaus, expending enormous sums of tax funds, are meeting the equalizing factor of the spontaneous rigidity of the will of the individual taxpayer.

At the hearings which I refer to, I listened carefully to the testimony of the governmental bureaus, especially that of Dr. Reichelderfer, of the United States Whether Bureau. He made such statements as:

"The estimated cost of past cloud seeding experiments by the Federal Government is of the order of $10 million."

"A review of the extensive experimentation in cloud seeding which has been undertaken throughout the world, indicates that the results to the present time have been inconclusive and indefinite."

Now, conversely, let's look at the progress factually achieved for one-tenth the research costs. This, then, does not demonstrate the practical sense of again waiting another 10 years for indefinite answers from governmental bureaus. This, too, represents only strides made within our own organization.

Let's not assume a one-sided record nor that it requires a governmental bureau to progress a science.

The following developments of major importance were achieved by Water Resources Development Corp. during the period 1946 through 1956:

1. Development and perfection of the first successful coke-burning ground generator capable of effectively producing rainfall increases over what may naturally occur.

2. Developed two successful techniques to properly trace from ground to air the dispersion, rate of rise and plume effects of ground generator particles in the free atmosphere. This accomplished through the use of "no lift" balloons with theodolite tracking and dispersing of a fluorescent particle readable under "black light." These particles can be collected and plume diffusion plotted by use of our designed airborne instrumentation, flying a predesigned collection course.

3. Developed and perfected the first workable ground generator with no moving parts and an operational-failure design of 1 time in 2 million starts.

4. Researched the first field studies of the physical effects of ground generators on cloud development, not only from theory, but by actually studying physically from aircraft.

5. Developed and designed well-engineered parameters prerequisite to successful operations. Such parameters secured from a detailed analysis of over 300,000 properly logged field operations in many States of the United States and several foreign countries. These allow us to analyze and value such factors as wind directions and speeds at various levels, moisture content of atmosphere, vertical motion of air, freezing temperature levels, inversions, etc.

6. Reviewed and tested all known means of evaluation techniques, and developed a few of our own.

7. Developed and perfected the fuel formula and processes for proper varying concentrations of burning in ground generators, to coincide with atmospheric conditions.

8. Developed and perfected means of postanalysis of weather conditions applicable to project areas to predetermine possible chances of success.

9. Developed and perfected electronic reading units to give advance warnings of hail and lightning potential prior to any possible chance of warning by radar.

10. Developed one of the best nuclei counters in the world.

11. Developed mechanical and slide-rule type instruments to hasten the plotting of predetermined plume diffusion charts prior to starting generator operations.

12. Developed long-term studies of readings of natural nuclei counts in great segments of the United States.

13. Developed the first practical ground-based generator operation of hail-suppression procedures. We made proper laboratory studies to determine chances of success of hail suppression. Then, with high loss factor of human life, actually gained our practical knowledge of hail formation and effects of certain chemicals on reduction by physically flying into and through hail-forming and bearing clouds. Our physical observations were properly logged reflecting the natural development. Then, releasing high concentrations of chemicals from aircraft within the cloud, we truly observed the effects of such chemicals on natural hailstones. In other words, our successes in suppression of hail is not based on idle theory, laboratory fancy, or speculation, but on human physical observation within existing atmospheric conditions.

14. Performed the first successful flatlands ground-generator type of weather modification.

15. Developed the first practical ground-based generator to release salt particles for the seeding of warm clouds. Have performed such commercial operations for sugarcane industry in French West Indies with good results.

16. Developed instrumentation for the control of operations to assist in the location and suppression of lightning.

17. Made some of the first studies of the potentials of wind, tornado, and hurricane suppression.

18. Developed one of the first means of progressing the installation of radio or telephone-controlled generators to operate from centrally located control panels.

19. Developed an integrated central and local control of project area operations to insure greatest introduction of all factors of technical personnel.

20. Developed the largest private weather analysis and control center in Denver in the world.

21. First to apply the use of electronic computing brains, Univac, to assist in determining chances of rainfall increases in project areas.

22. Performed the first controlled ground generator randomized seeding project in Israel. It was calculated that it would require about 100 years of operations by this selective method to acquire results that may be evaluated.

23. Performed the first mass ground seeding to determine if man could overseed and therefore suppress rain.

Such positive progress for a fraction of funds expended by Government bureaus reflects the savings and ability of private enterprise to get the job done. It negates the contention that Government bureaus should spend the appropriations of Senate bill S. 86.

To further emphasize the positive side of the successes being achieved throughout the world, may I quote excerpts from and refer you to the complete reports of—

A. The second report on cloud-seeding experiments over Sun Moon Lake area by Taiwan Rain Stimulation Research Institute, T'ai-pei, Taiwan, China, April 1956, states: "Counting for the irregular climatic fluctuations and the statistical errors, one may conclude that the rainfall at the target area, the vicinity of the upper streams of Sun Moon Lake, did increase due to the cloud-seeding activities, and the average increase in rainfall during the 1951–52, 1952–53, and 1953–54 Sun Moon Lake dry seasons is 15 percent."

B. Report No. 341, prepared by American Institute of Aerological Research on the Water Resources Development Corp. operations in the island of Grande Terre in the French West Indies, reflects the proportional increase in precipitation occurring over the sugarcane plantations, appears to have been of the order of 10 percent—as promised client by Water Resources Development Corp. in a preoperational survey of potentials.

C. A report by E. G. Bowen, radiophysics division, Commonwealth Scientific and Industrial Research Organization, of Sydney, Australia, reporting on seeding operations in the Snowy Mountains area of Australia, reflects: "The experiment has been in progress 9 months and the results are not expected to be statistically significant until approximately 24 months have elapsed. However, up to the present time, there is a net increase of 30 percent in the precipitation in the target area." (Extracted from proceedings of the conference on the scientific basis of weather modification studies, April 12, 1956, at Institute of Atmospheric Physics, University of Arizona, Tucson, Ariz.)

D. Also at this same conference, Dr. H. Weickmann, Signal Corps Engineering Laboratories, Fort Monmouth, N. J., reported on stratus cloud seeding in Western Germany, January and February 1956, as: "While any conclusions at this time must be preliminary, it can be said that the results of the tests confirmed the encouraging results obtained previously in the United States."

E. A report of artificial snowfall from mountain clouds in Scandinavia by F. H. Ludlam, reprinted from Tellus, volume 7, No. 3, August 1955, reads: "The estimated maximum attainable increases in the mountain snow cover and spring flood discharge of the rivers in the region considered amounts respectively to about 10 percent and 25 percent of the normal values. Such increases would be easily noticeable. However, it must be emphasized that these estimates are tentative, and it is unlikely that present seeding techniques have a very high efficiency."

F. The division of hydrology, Électricité de France (whose head is also president of the French Meteorological Society) under direction of studies and research applied statistical tests to the control of cloud seeding operations in their report of October 1956, reflects: "For the first winter, significant increase (1954–55) of 42.3 percent; for the second winter (1955–56) of 78 percent; for each year taken individually, 1954–55, 26.5 percent; 1955–56, 19 percent; for the series of 2 consecutive years, 1954–56, 23.7 percent; all this allows us to state increases experienced on the annual scale are very similar to those indicated by the Advsory Committee on Weather Control. They are even a little greater, doubtless due to the excellent natural location of the watershed and the competence of the operating company, which was Water Resources Development Corp., of Denver. Colo."

G. President Eisenhower's Advisory Committee on Weather Control noted that: "The Committee's staff has analyzed, statistically, a project in Switzerland, carefully conducted under scientific auspices, and the analysis shows a

50 percent reduction in hail. Personal testimony from an area visited by Committee members in this country, indicates almost absolute suppression of hail. This evidence is fragmentary. However, it is impressive enough, and the staff's belief in the theoretical possibilities is great enough, to warrant the closest interest in commercial hail suppression projects."

H. A project of rainmaking in Japan, volume 1, 1954, by the committee for rainmaking in Japan, Meteorological Research Institute Mabashi, Suginam, Tokyo reflects: "During the period from September 1953 to February 1954, smoke generators by electric heating were installed at seven different hydropower stations. A statistics analysis of the data of weather supplied from meteorological observatories shows that during this total period, the affected spots had more rainfall in comparison with the not affected spots by 20 percent."

Our organization does not perform so-called hit-and-miss operations or ill-designed programs. We, too, are steeped in proper academic background. For 15 years, our president, Dr. Irving P. Krick, and his colleagues who are now executives of our company formed the department of meteorology at the California Institute of Technology at Pasadena, Calif. In 1948, when Dr. Robert A. Millikan, head of that institution, retired, it was this group that divorced their operation from Cal-Tech to form a nonprofit research foundation, the American Institute of Aerological Research, which is still in existence. It was this foundation that carried on, in 1948, the original work in cloud physics being progressed at Cal-Tech since 1946 and, in 1950, had sufficiently developed proper tested and engineered equipment and techniques to turn over to our above-named commercial company. This foundation continues research, development, and evaluation in this important field.

Since 1950, our commercial company, Water Resources Development Corp., has performed weather modification operations within 27 States of the United States, Canada, and 9 other foreign countries. We have amassed over 650,000 hours of commercial field tests in most of the climatic zones of both hemispheres.

True, in the early period of 1950 and 1951, we were selling short-term projects in any area requesting same. But, we soon realized this would not produce the proper evaluation picture nor afford the opportunity to learn and progress. So, in 1952, we adopted a policy of selectiveness in accepting contracts to insure optimum design and to furnish important data, with emphasis on those areas where small increases and timely rains had most economic potential—South Dakota is one such example.

This 650,000 hours of well-documented data when combined, represents about 40 years of experience, if the projects were progressed in a single location.

Our project areas in the United States are spread from Washington and Oregon, on the west coast, to Georgia and Florida on the east coast. We have gained invaluable experience in mountainous areas, most easily operated, and over flatland areas, which offer different and more complex operational problems. I mentioned this point because of the many references in the testimony of others that flatland operations are not feasible. This is not correct. True, different problems are present, but they have been resolved. Certain weather situations do not respond to cloud seeding over flatland. We recognize and consider this in the evaluation of our capabilities here. Our company has been seeding in flatland areas of the United States and many foreign countries for years and have obtained worthwhile results. It would be safe to state that we have about 325,000 flatland operational hours of well-documented data.

There is no group, private or governmental, that has achieved operational experience over such extensive areas or for such long periods of time over both flatland and mountainous areas as our company. It is the flatland areas that suffer the greatest ravages and repetitions of drought and that do so much to weaken the economy of our country and the world. Therefore, to the logical person, this long record of operational experience would have demonstrated certain obvious facts.

Several of our projects have been under operational contracts since 1950. Surely, no group is sufficiently clever to delude or fool intelligent people for this duration of time.

Our research program has been constructive and progressive. We have covered exhaustively most of the pertinent points of developing a well-engineered product. However, working intimately with the subject day in and day out has brought to our attention many facets that must be continually explored

and developed to further advance this new science. This intimacy with the subject is something like marriage—the faults and good points are brought into sharp focus.

A few of our research-project reports have been printed in scientific journals but many have not. We are a private enterprise and our clients' wishes must be honored. Therefore, a good bulk of our material is not generally circulated or published. However, we have done our utmost to cooperate with the Advisory Committee where requests by this group have been made.

Many argue that ground-based generators cannot effectively emit particles that will rise to proper evaluations in flatland areas to become effective. We have carried on extensive studies to disprove this contention. These studies were made by use of no-lift balloons, special tracer particles released from ground locations and collected by our own designed aircraft collectors, and airborne nuclei counters.

Many statements were made about there being a sufficient number of natural particles present in the atmosphere to stimulate the rain process and that further seeding would have no effect. This statement exposes an ignorance of certain pertinent truths. It is not the number of natural nuclei present that is of most importance, but the moisture content availability and temperature response levels of both natural and artificial nuclei that determine cloud seeding efficiencies. The airstream could be completely saturated with natural particles, and if the other relationships were not present, rainfall would not occur. However, under certain of these situations, the introduction of artificial nuclei from ground generators may materially augment rainfall.

Another point was made that in situations of temperature inversion, any nuclei released at ground level would not reach effective seeding levels. This is partially correct. However, any well-qualified private operator knows these facts and how to properly deal with such situations.

We have performed continuing measurements of natural nuclei counts by placing our counters at strategic points from the State of Washington to the State of Colorado. Daily counts of natural nuclei have been progressed for several years. These data permit factual analysis as to possible effects of both natural nuclei and artificial nuclei on rainfall or cloud development.

Many comments were made concerning necessity of random experiments—but may I quote Capt. Fred A. Berry, scientific adviser to President Eisenhower's Advisory Committee on Weather Control. (Report of Weather Control Research Association Meeting, Edison Building, Los Angeles, Calif., March 23, 1955, p. 62):

"Some of the scientists would like us to quit all this and sit back and wait until they come up with a completely demonstrated and proved theory on how, why, when, and where this works. Some of us have heard this old yarn many times, but there was a lot of agitation before 1900 in England that since the weather forecasts were so poor, they better quit making forecasts until they learned all about the weather. Well, you can see if they had done that, we wouldn't be forecasting yet. There is the thing we know (with what I call a reasonable degree of certainty)—there is an economic benefit back which seems to be slightly greater than the cost, and I don't believe that we should abandon that and sit down and run a randomized experiment for 10 years in order to get a little more firm in our conclusions. Some of us feel that the randomized experiment achieves only one aim which is to destroy half of your data; that you do better if you don't randomize it and use all your data. There are two opposite statistical schools of thought. Our people happen to belong to the one which is against randomization. Now I grant you that we are all for basic research. Just like God, mothers, the American flag, and apple pie on Sunday, everybody's for basic research. Most of us are engineers, too. We can't see any essential conflict. I think you can go ahead with your engineering approach, and as your basic research finds out more about this, you crank that into your engineering and I believe that is the proper way to tackle the thing."

For the record, attached is a bibliography on weather modification and field operations—a record of some of the comprehensive and short reports that have been prepared on weather modification by our group.

PAUL J. CAUBIN.

A Bibliography on Weather Modification and Field Operations Using the Combined Facilities of Irving P. Krick Associates, Inc., American Institute of Aerological Research, Water Resources Development Corp., February 1957

LEGEND

A=American Institute of Aerological Research

C=California Institute of Technology

K=Dr. Irving P. Krick

W=Water Resources Development Corp.

Report No.	Title	Date
1-K	Report on Meteorological Aspects Artificial Nucleation Phoenix Area in Summer. For Arizona Weather Research Foundation.	July 1948.
2-K	Report on Meteorological Aspects of Artificial Nucleation in San Diego Mountain Area in Summer. For irrigation and power interests.	Do.
3-K	Preliminary Report on July Operations of Artificial Nucleation in Phoenix Area. For Arizona Weather Research Foundation.	August 1948.
4-K	Supplement No. 1 to Report on Meteorological Aspects of Artificial Nucleation in the San Diego Mountain Area in Summer. For irrigation and power interests.	September 1948.
8-K	Report on Artificial Nucleation Experiments in the Logo Toronto Area of Mexico. For Cia Agricola Y Fuerza-Electricia Del Rio Conchos, S. A.	November 1948.
10-K	Evaluation of Cloud Seeding Operations in the Phoenix Area During the Summer of 1948. For Arizona Weather Research Foundation.	December 1948.
2A-K	Evaluation of Artificial Nucleation Over the Lake Henshaw Watershed, August 1948 to May 1949. For Vista Irrigation District.	May 20, 1949.
16-K	Evaluation of Cloud Seeding Operations in the Phoenix Area. For the Arizona Weather Research Foundation.	September 1949.
24-A	Progress Report on Survey of Sites in New Mexico Suitable for the Artificial Stimulation of Precipitation Through Cloud Seeding in the Rio Grande Drainage Basin. For New Mexico Development Commission, Santa Fe, N. Mex.	Feb. 3, 1950.
95-W	Survey of Potential Effects of Artificial Cloud Seeding in the Horse Heaven Area. For Horrigan Farms, Prosser, Wash.	Apr. 24, 1950.
27-A	Evaluation of the Results of Aerial Cloud Seeding Operations in the Necaxo Region, Mexico, During the Period June through October 1949. For Compania Mexicana De Luz Y Fuerza Motriz, S. A.	May 1, 1950.
28-A	Prospects for Seeding in the Necaxa Region With Silver Iodide Generators Located on the Ground. For Compania Mexicana De Luz Y Motriz, S. A.	Do.
33-A	Analysis of Cloud Seeding Potentialities To Increase Natural Precipitation in Southeastern Colorado. For Southeast Weather Research Association.	June 29, 1950.
53-A	Preliminary Report of Cloud Seeding Operations, Eastern Washington, June 1950. For Horrigan Farms.	June 29, 1950.
32-A	Analysis of Cloud Seeding Potentialities To Increase Natural Precipitation in Northeastern New Mexico. For northeast New Mexico project. Prepared for Albert K. Mitchell by AIAR.	July 15, 1950.
35-A	Analysis of Cloud Seeding Potentialities To Increase Natural Precipitation in Northeastern Colorado. For Northeastern Colorado Water Development Corp. Prepared for Water Resources Development Corp.	Aug. 1, 1950.
36-A	Analysis of Cloud Seeding Potentialities in Camas Valley, Idaho. For Camas Weather Research Co. Prepared for Water Resources Development Corp.	Do.
40-A	Analysis of Cloud Seeding Potentialities To Increase Natural Precipitation in Morrow, Gilliam and Sherman Counties (Oreg.). For Tri-County Weather Research Corp. Prepared for Water Resources Development Corp.	Do.
39-A	Analysis of Cloud Seeding Potentialities To Increase Natural Precipitation in Antelope Valley, Calif. For Antelope Valley Water Development Corp. Prepared for Water Resources Development Corp.	Aug. 11, 1950.
112-W	Report on Cloud Seeding Operations in Southeast Colorado During July 1950. For Weather Research Association of Southeast Colorado. Prepared for Water Resources Develop-Corp.	Aug. 15, 1950.
38-A	Analysis Cloud Seeding Potential Lewis River Ariel Dam Watershed, Washington. For Pacific Power & Light.	Aug. 20, 1950.
37-A	Analysis of Cloud Seeding Potentialities To Increase Natural Precipitation in Santa Barbara County, Calif. For Santa Barbara County Water Agency. Prepared for Water Resources Development Corp.	Sept. 20, 1950.

A Bibliography on Weather Modification and Field Operations Using the Combined Facilities of Irving P. Krick Associates, Inc., American Institute of Aerological Research, Water Resources Development Corp., February 1957—Continued

Report No.	Title	Date
113-W	Cloud Seeding Operations in Southeast Colorado During August 1950. For Weather Research Corp. of Southeast Colorado. Prepared for Water Resources Development Corp.	Sept. 30, 1950.
115-W	Cloud Seeding Operations in Northeastern New Mexico Area for August 1950. For Eastern New Mexico Weather Research Association.	Do.
43-A	Analysis of Cloud Seeding Potentialities in Sunflower Valley (Calif.) and Adjacent Areas. For Santa Clara County Survery. Prepared for Water Resources Development Corp.	Oct. 9, 1950.
44-A	Analysis of Cloud Seeding Potentialities in Southeast Arizona. For Southeast Arizona Weather Research Corp. Prepared for Water Resources Development Corp.	Oct. 15, 1950.
114-W	Cloud Seeding Operations in Southeast Colorado During August-September 1950. For Weather Research Corp. of Southeast Colorado. Prepared for Water Resources Development Corp.	Nov. 1, 1950.
116-W	Cloud Seeding Operations in the Northeastern New Mexico Area for August-September 1950. For Eastern New Mexico Weather Research Association. Prepared for Water Resources Development Corp.	Do.
54-A	Preliminary Reports (1, 2, 3) on the Analysis of Cloud Seeding Seeding Potentialities of the Upper South Platte Drainage Basin (Colorado). For Platte Valley Water Resources Association.	Nov. 2, 1950.
45-A	Analysis of Cloud Seeding Potentialities in Big Bend Area of Washington. For Big Bend Water Development Corp. Prepared for Water Resources Development Corp.	Nov. 24, 1950.
47-A	Analysis of Cloud Seeding Potentialities in Black River Drainage Basin Above Hatfield (Wis.). For Mississippi Valley Public Service Co. Prepared for Water Resources Development Corp.	Jan. 15, 1951.
48-A	Analysis of Cloud Seeding Potentialities in Plains of Northeastern Colorado. For Northeastern Colorado Water Development Association. Prepared for Water Resources Development Corp.	Jan. 23, 1951.
46-A	Analys s of Cloud Seeding Potentialities in Santa Clara County (Calif.). For Santa Clara County. Prepared for Water Resources Development Corp.	Jan. 24, 1951.
56-A	Report on Cloud Seeding Operations for Camas Valley, Idaho (July, September, October, 1950). For Camas Weather Research Co. Prepared for Water Resources Development Corp.	Apr. 5, 1951.
51-A	Some Evaluations of Sustained Cloud Seeding Operations. By Irving P. Krick and T. B. Smith. Presented at 32d Annual Meeting of the American Geophysical Union at Washington, D. C. Apr. 30, 1951.	Apr. 25, 1951.
50-A	Preliminary Report Cloud Seeding Potentialities Hebbronville Area, Texas. For Brooks-Jim Hogg Agricultural Development Association. Prepared for Water Resources Development Corp.	Apr. 28, 1951.
58-A	Preliminary Report Cloud Seeding Potentialities Brule, Buffalo, Gerauld, Aurora Counties (S. Dak.). For Western South Dakota Rain Increasing Corp.	May 15, 1951.
59-A	Preliminary Report Cloud Seeding Potentialities Southern Utah. For Southern Utah Water Resources Development Corp.	Do.
60-A	Preliminary Report Cloud Seeding Potentialities the Grand River Valley Area of North and South Dakota. For Grand River Valley Weather Improvement Association.	Do.
85-A	Preliminary Report, Cloud Seeding Potentialities Southwestern Nebraska. For Southwestern Nebraska Weather Improvement Association.	May 21, 1951.
71-A	Preliminary Report Cloud Seeding Operations, San Luis Valley, Colo., January 21-April 30, 1951. For San Luis Valley Weather Corp. Prepared for Water Resources Development Corp.	May 23, 1951.
61-A	Analysis of Cloud Seeding Potentialities in Southwestern Colorado. For San Juan Weather Improvement Association. Prepared for Water Resources Development Corp.	May 31, 1951.
62-A	Analysis of Cloud Seeding Potentialities in Laramie County, Wyo. For Wyoming Weather, Inc. Prepared for Water Resources Development Corp.	Do.
63-A	Analysis of Cloud Seeding Potentialities in Baker and Union Counties, Oreg. For Agricultural Interests. Prepared for Water Resources Development Corp.	Do.
93-A	Snow Pack Increase in the Colorado Rockies by Artificial Nucleation. By Irving P. Krick for Research. Prepared for Water Resources Development Corp.	May 31, 1951.

A Bibliography on Weather Modification and Field Operations Using the Combined Facilities of Irving P. Krick Associates, Inc., American Institute of Aerological Research, Water Resources Development Corp., February 1957—Continued

Report No.	Title	Date
64-A	Analysis of Cloud Seeding Potentialities in Southwestern Nebraska. For Southwest Nebraska Weather Improvement Association, Inc. Prepared for Water Resources Development Corp.	June 15, 1951.
65-A	Analysis of Cloud Seedling Potentialities in Southern Utah. For Southern Utah Water Resources Development Corp. Prepared for Water Resources Development Corp.	Do.
66-A	Analysis of Cloud Seeding Potentialities to Increase Natural Precipitation in Brule, Buffalo, Gerauld, Aurora Counties, S. Dak. For Western South Dakota Rain Increasing Corp. Prepared for Water Resources Development Corp.	Do.
72-A	Report on Cloud Seeding Operations Southeast Arizona, Dec. 26, 1950–Apr. 30, 1951. For Southeastern Arizona Water Resources Corp. Prepared for Water Resources Development Corp.	June 21, 1951.
67-A	Analysis of Cloud Seeding Potentialities to Increase Natural Precipitation in the Grand River Valley Area of North and South Dakota. For Grand River Valley Weather Improvement Association. Prepared for Water Resources Development Corp.	June 30, 1951.
68-A	Analysis of Cloud Seeding Potentialities To Increase Natural Precipitation In The Area of Matamoras, Tam, Mexico. For Comite Regional de Defense Agricola. Prepared for Water Resources Development Corp.	June 30, 1951.
69-A	Analysis of Cloud Seeding Potentialities To Increase Natural Precipitation in Coastal Bend Area, Texas. For Coastal Bend Agricultural Committee. Prepared for Water Resources Development Corp.	Do.
73-A	Report on Cloud Seeding Operations, Antelope Valley, Calif. For Antelope Valley Water Development Corp.	July 13, 1951.
83-A	Report on Cloud Seeding Operations Northern Colorado. For Northern Colorado Natural Resources Association.	Sept. 7, 1951.
74-A	A Report on Cloud Seeding Operations in Upper Rio Grande Basin, N. Mex., February–June 1951. For Moisture Production Corp. Prepared for Water Resources Development Corp.	Sept. 28, 1951
77-A	Report on Cloud Seeding Operations, Horse Heaven Area, Washington. September 1950–June 1951. For The Horse Heaven Water Development Corp. Prepared for Water Resources Development Corp.	Do.
78-A	Report on Cloud Seeding Operations, Big Bend Area, Washington, October 1950–June 1951. For the Big Bend Water Development Corp. Prepared for Water Resources Development Corp.	Do.
80-A	Final Report Analysis of Cloud Seeding Potentialities To Increase Runoff in the Columbia River Basin Above Grand Coulee (Wash.). For Bonneville Power Administration.	Sept. 30, 1951.
81-A	Analysis of Cloud Seeding Potentialities in Southern California. For Research.	Oct. 26, 1951.
75-A	Report on Cloud Seeding Operations Southeastern Arizona, Dec. 26, 1950–Oct. 31, 1951. For Southeast Arizona Weather Research Corp. Prepared for Water Resources Development Corp.	Nov. 9, 1951.
79-A	Report on Cloud Seeding Operations for Eastern New Mexico Weather Research Association, Mar. 1–Oct. 31, 1951. Prepared for Water Resources Development Corp.	Nov. 15, 1951.
76-A	A Study of the Weather Factors Which Contribute To Winter Wheat Yields in Morrow, Sherman, and Gilliam Counties, Oreg.	Dec. 3, 1951.
103-W	Analysis of Cloud Seeding Operations for Tri-County Weather Research, Inc. (Oregon) September 1950 through June 1951, final report.	1952.
104-W	Analysis of Cloud Seeding Operations for Southwestern Nebraska Weather Improvement Association, Inc., Apr. 15 through Oct. 12, 1951, final report.	1952.
105-W	Analysis of Cloud Seeding Operations. For Northwest Nebraska Water Resources Development Corp., May 15 through Oct. 12, 1951, final report.	1952.
106-W	Analysis of Cloud Seeding Operations for Border Livestock Association (Texas), Mar. 7–July 15, 1951, final report.	1952.
107-W	Analysis of Cloud Seeding Operations for Coastal Bend Agricultural Improvement Association (Texas), Mar. 13–July 15, 1951, final report.	1952.
108-W	Analysis of Cloud Seeding Operations for Brooks-Jim Hogg Agricultural Development Association (Texas), Mar. 8 through Oct. 31, 1951, final report.	1952.
109-W	Analysis of Cloud Seeding Operations for Weather Improvement Corp., (of Montana), May 15 through Sept. 30, 1951, final report.	1952.

A Bibliography on Weather Modification and Field Operations Using the Combined Facilities of Irving P. Krick Associates, Inc., American Institute of Aerological Research, Water Resources Development Corp., February 1957—Continued

Report No.	Title	Date
110-W	Analysis of Cloud Seeding Operations for North Central Washington Water Development Corp., June 1 through June 30, 1951.	1952.
111-W	Final Operation Report for Southeast Arizona Weather Research Corp., Jan. 1-Dec. 30, 1951.	1952.
118-W	Final Operations Report for Northwestern Colorado Weather Improvement Corp., May 1, 1951-Apr. 30, 1952.	1952.
126-W	Final Operations Report for Western South Dakota Rain Increasing Corp.	1952.
128-W	Final Operations Report for West Central South Dakota Weather Improvement Association.	1952.
151-W	Final Operations Report for Tri-County Weather Research, Inc. (Oregon).	1952.
152-W	Final Operations Report for Blue Mountain Weather Research Association (Oregon).	1952.
153-W	Final Operations Report for Horse Heaven Water Development Corp. (Washington).	1952.
154-W	Final Operations Report for Big Bend Water Development Corp. (Washington).	1952.
155-W	Final Operations Report for North Central Washington Water Development Corp.	1952.
156-W	Final Operations Report for Lincoln Water Development Corp. (Washington).	1952.
303-W	Washington and Oregon, Individual Storm Studies for June 1952. Project covered Big Bend, Blue Mountain, Horse Heaven, Lincoln, North Central Washington, and Tri-County.	1952. 1952.
88-A	Report on Cloud Seeding Operations for El Salvador, C. A. (Mar. 15, 1951-Oct. 31, 1951). For: Cia Salvadorena de Cafe.	Jan. 31, 1952.
89-A	Analysis of Cloud Seeding Potentialities in the Colorado River Basin of Texas. For Lower Colorado River Authority.	Jan. 31, 1952.
101-W	Report of Cloud Seeding Operations, Northwestern Kansas, April to June and August to October 1951. For the High Plains Water Resources Development Association.	Mar. 7, 1952.
70-A	A Report on Cloud Seeding Potentialities in Central Cuba. For American Sugar Refining Co., Cunagua and Jaronu. Prepared for Water Resources Development Corp.	Mar. 25, 1952.
90-A	Final Report, Analysis of Cloud Seeding Operations To Increase Runoff in the Pend Oreille River Basin. For Bonneville Power Administration. Prepared for Water Resources Development Corp.	Mar. 31, 1952.
86	Evaluation of Cloud Seeding by Physical and Synoptic Approaches. By Newton C. Stone and Lewis O. Grant. Paper presented at 116th National Meeting of American Meteorological Society, Corvallis, Oreg., June 17, 1952, by N. C. Stone.	July 10, 1952.
91-A	Analysis of Cloud Seeding Potentialities to Increase Precipitation in Tunisia. For M. Leo D'Erlanger.	July 15, 1952.
129-W	Final Operating Report 1952, for Weather Improvement Corp. (Montana).	Oct. 16, 1952.
130-W	Final Operating Report, 1952, for Western South Dakota Rain Increasing Corp. and West Central South Dakota Weather Improvement Association.	Do.
131-W	Final Operating Report, 1952, for North Central Weather Modification Corp. and Southwest Rain Corporation of North Dakota, ND 4 and 5.	Do.
132-W	Final Operating Report, 1952, for Powder River Weather Research Corp. (Weston County, Wyo.), and Powder River Weather Research Corp. (Converse and Niobrara Counties, Wyo.).	Do.
133-W	Operating Report for Southeastern Arizona Weather Research Corp., 1952.	Oct. 24, 1952.
134-W	Operating Report, April-September, 1952, for West Texas Weather Improvement District.	Do.
135-W	Operating Report, 1952, for Panhandle Weather Improvement Association (Oklahoma-Texas).	Oct. 30, 1952.
159-K	Increasing Water Resources Through Weather Modification. Address given at annual meeting of the American Water Works Association, Kansas City, Mo., May 7, 1952. Published in Journal American Water Works Association. Vol. 44, No. 11, November 1952.	November 1952.
136-W	Operating Report, 1952, for Eastern New Mexico Weather Research Association.	Nov. 5, 1952.
138-W	Operating Report, April-September 1952, for T-O Moisture Improvement Association (Oklahoma-Texas).	Do.
137-W	Operating Report, December 1951-September 1952, for San Ysidro Range Improvement Association (New Mexico).	Nov. 20, 1952.
189-W	Operations Report for Northeastern Colorado Water Development Association, February 1951-January 1952, April-September 1952.	Dec. 1, 1952.

A Bibliography on Weather Modification and Field Operations Using the Combined Facilities of Irving P. Krick Associates, Inc., American Institute of Aerological Research, Water Resources Development Corp., February 1957—Continued

Report No.	Title	Date
140-W	Operating Report for Three Rivers Weather Research Corp., April-September 1951 (Montana).	Dec. 2, 1952.
141-W	Terminating Report, October and November 1952, for San Ysidro Range Improvement Association (New Mexico).	Jan. 6, 1953.
117-W	January 1953 in the Pacific Northwest	February 1953.
160-K	Increasing Water Resources Through Cloud Seeding. Address delivered at Second Ohio Water Clinic. Published by Ohio State University, Columbus, Ohio.	Do.
142-W	Final Operating Report for Southeast Arizona Weather Research Association, 1952 excluding May and June.	Mar. 16, 1953.
143-W	Final Operating Report, October-December 1952. For West Texas Weather Improvement District. WRDC.	Mar. 18, 1953.
102-W	Operational Report April-September 1951, WY-1. For Powder River Weather Research Corp.	Mar. 25, 1953.
119-W	Snowpack Operation, Utah, 1952-53. For Richfield, Utah Meeting, Apr. 27, 1953.	April 1953.
120-W	Precipitation Values in Utah, April 1950-March 1951, April 1952-March 1953. For Utah County Commissioners.	Do.
161-K	Evidence of Manmade Climatic Change. Prepared for WRDC by IPK.	Do.
145-A	Final Operating Report, Nov. 8, 1952-Mar. 8, 1953. For Platte Valley Water Users Association and Northern Colorado Natural Resources Association. Prepared by AIAR for WRDC.	Apr. 8, 1953.
98-A	Survey To Determine the Feasibility of Cloud Seeding Operations in Morocco. For Energie L'Electrique du Maroc.	Apr. 10, 1953.
146-A	Supplement to Final Operations Report, 1952. For Weather Improvement Corp. (M-2). Prepared by AIAR for WRDC.	May 1, 1953.
147-W	Operations Report, Nov. 22, 1952-May 22, 1953. For city of Dallas, Tex. Prepared by WRDC for IPK, Inc.	June 9, 1953.
148-W	Operations Report, September 1952-March 1953. For Pacific Power & Light Co. Prepared for WRDC by AIAR.	June 16, 1953.
149-W	Operations Report, November 1952-March 1953. For British Columbia Electric Co., Ltd. Prepared for WRDC by AIAR.	Do.
150-A	Operations Report, Jan. 1-Apr. 10, 1953. For Northwest Colorado Weather Improvement Corp. Prepared for WRDC by AIAR.	June 22, 1953.
144-W	Final Operating Report, October 1952-March 1953. For T-O Moisture Improvement Association.	July 22, 1953.
170-A	Operations Report, October 1952-April 1953. For Panhandle Weather Improvement Association (OTK-1). Prepared by AIAR, for WRDC.	August 1953.
172-A	Operations Report, Apr. 1-May 19, 1953. For North Central Weather Modification Corp. (Ref: ND-4). By AIAR for WRDC.	Do.
182-A	Operations Report for Morocco. For Energie Electrique Du Maroc. By AIAR.	Do.
168-A	Operations Report 1951-52-53. For Western South Dakota Rain Increasing Corp. and West Central South Dakota Weather Improvement Association. By AIAR, for WRDC.	Aug. 20, 1953.
173-A	Operations Report, May-July 1953, MT-1 (Manitoba). For WRDC Modification Corp., Ltd., by AIAR for WRDC.	September 1953.
174-A	Operations Report, Apr. 15-July 15, 1953. For North Central South Dakota Rain Increase Corp. (reference: SD-4), by AIAR for WRDC.	Do.
176-A	Operations Report, May-September 1953. For Platte County Rain Increasing Association (reference: WY-6), by AIAR for WRDC.	Do.
179-A	Operations Report, June 1952-May 1953. For Southern Utah Water Resources Development Corp. (reference: U-1), by AIAR for WRDC.	Do.
183-A	Operations Report, Mar. 27-June 15, 1953. For Box Elder Farms Co. (reference: C-9), by AIAR for WRDC.	Do.
184-A	Operations Report, 1950-53. For Horse Heaven Water Development Corp. (W-1), Big Bend Weather Development Corp. (W-2), Blue Mountain Weather Research Association (O-4), (Umatilla County), by AIAR for WRDC.	Do.
171-W	Cloud Seeding Operations at Dallas, paper by I. P. Krick, presented Oct. 21, 1953, at Southwest Section Meeting, Houston, Tex., WRDC.	October 1953.
(Reprint)	Published in Journal American Water Works Association, November 1953; also paper by K. F. Hoefle, Meeting the Dallas Water Shortage.	
186-A	Operations Report, Jan. 1, 1953-Sept. 30, 1953. For West Texas Weather Improvement District (T-7), by AIAR.	Dec. 1, 1953.
185-A	Cloud Seeding in Israel (Preliminary Report), the Storm, Nov. 17-22, 1953, by AIAR.	Do.
187-W	Increasing Water Resources in Spain, Summary Report (Preliminary), the Rio Alberche Operation. For Union Electrica Madrilena, October 1952 through September 1953, by WRDC in association with Airfleets, Inc.	Dec. 30, 1953.

A Bibliography on Weather Modification and Field Operations Using the Combined Facilities of Irving P. Krick Associates, Inc., American Institute of Aerological Research, Water Resources Development Corp., February 1957—Continued

Report No.	Title	Date
175-A	Operations Report, Apr. 15-Oct. 31, 1953. SD-5, Hyde, Buffalo, Jerauld, Beadle, Aurora, and Hand Counties, by AIAR for WRDC.	January 1954.
189-A	Operations Report, Oct. 14, 1952, to Oct. 15, 1953. For Comanche County, Kans., Woodward County, Okla., Harper County, Okla. (Reference OK-3) by AIAR for WRDC.	Do.
192-A	Operations Report, Weather Modification Project, November 1953. Israel, by AIAR.	Do.
188-A	Report on Hail Suppression Experiment, Conducted for Washington and Logan Counties, Colo., July 2-Aug. 12, 1951. By AIAR for WRDC.	Jan. 8, 1954.
190-W	Report on Weather Modification Operations To Increase Precipitation in Spain, Oct. 1, 1952-Sept. 30, 1953. For the Ministries of Air and Agriculture, Madrid, Spain, by WRDC.	February 1954.
191-W	Report on Weather Modification Operations To Increase Streamflow in the Alberche River, Oct. 1, 1952-Sept. 30, 1953. For Union Electrica Madrilena, Madrid, Spain, by WRDC.	Do.
194-A	Operations Report, Weather Modification Project, December 1953. Israel, by AIAR. (Confidential.)	Do.
196-A	Review of AIAR Field Research in 1953. (Distribution restricted.)	Mar. 1, 1954.
195-W	Typical Cloud-Seeding Operations 1948-53. Seeding manual, by WRDC.	February 1954.
197-A	Operations Report, Weather Modification Project, January 1954. Israel, by AIAR. (Confidential.)	March 1954.
198-W	Report of Weather Modification Operations to Increase Precipitation in Spain. Summary of Ppt. over Iberian Peninsula, October 1952 through December 1953. For the Ministries of Agriculture and Air, Madrid, Spain, by WRDC.	March 1954.
200-W	Lightning Suppression, Aid to Forest Fire Control, by WRDC	April 1954.
204-K	Technical and Economic Aspects of Weather Modification in Relation to Water Supply. By I. P. Krick. Draft of article prepared for the Institute of Water Engineers, London, England.	May 1954.
205-K	Weather Control Progress, by I. P. Krick. Draft of address presented at annual conference of the American Waterworks Association, Seattle, Wash., May 25, 1954.	Do.
202-A	Operations Report, Weather Modification Project, February 1954. Israel, by AIAR. (Confidential.)	Do.
203-K	Assessing the Value of Cloud-Seeding Operations to Water Supply, by I. P. Krick. Draft of address read by E. M. Frisby at annual conference of British Waterworks Association at Bournemouth, England, June 30, 1954.	June 1954.
208-A	Operations Report, Weather Modification Project, March 1954. Israel, by AIAR. (Confidential.)	Do.
209-A	Cloud Seeding Potentialities on the Island of Grande Terre in the French West Indies, to Syndicate of Producers-Exporters of Sugar and Rum of the Guadeloupe and Dependencies. Prepared for WRDC by AIAR.	June 30, 1954.
210-A	Operations report, weather modification project, Israel, April 1954, by AIAR. (Confidential.)	July 1954.
Correction note	Please change date of publication of Report 191-W to April 1954.	
211-A	Operations report, Dec. 26, 1953-May 2, 1954 (reference: C-8). For Platte Valley Water Resources Association by AIAR for WRDC.	July 15, 1954.
212-A	Operations report, Feb. 12, 1954-Apr. 23, 1954 (reference: WY-7). For Wyoming Weather, Inc., by AIAR for WRDC.	Do.
215-A	Operations report, Nov. 1, 1953-May 11, 1954 (reference: OC-1). For the city of Oklahoma City, by AIAR for WRDC.	July 27, 1954.
217-W	Weather modification operations to increase streamflow in the Alberche River, Spain, 15 months' precipitation summary, October 1952 through December 1953. For Union Electrica Madrilena, Madrid, Spain by WRDC.	July 1954.
214-A	Operations Report, May 15, 1953 to May 14, 1954 (reference: U-1). For Southern Utah Water Resources Development Corp., by AIAR for WRDC.	August 1954.
216-A	Cloud Seeding Review, 1950-54. For Horse Heaven Water Development Corp. (Reference: W-1), Big Bend Water Development Corp. (reference: W-2), Blue Mountain Weather Research Association (reference: O-4), by AIAR for WRDC.	Do.
218-A	Review of Sustained Cloud Seeding Operations in Utah, New Mexico, Pacific Northwest, Colorado Rockies, and Spain. By AIAR for WRDC.	Aug. 11, 1954.
220-A	Water Resources Development Corp. Cloud Seeding Review, 1951-54. For SD-1, 2, 3, 4, 5, by AIAR for WRDC.	September 1954.
223-A	Interim Report on Israel Weather Modification Project. By AIAR.	Do.
222-A-K-WRDC	Hail Suppression Theory and Practice. By AIAR—WRDC—Irving P. Krick, Meteorological Consultant, Inc.	October 1954.

A Bibliography on Weather Modification and Field Operations Using the Combined Facilities of Irving P. Krick Associates, Inc., American Institute of Aerological Research, Water Resources Development Corp., February 1957—Continued

Report No.	Title	Date
206-W	Effects of Climate and Weather on Real Estate Values. By Paul E. Ruch (reprint from the Appraisal Journal of October 1954). Address given to real-estate appraisal group in Chicago, May 7, 1954, by Paul E. Ruch.	May 1954.
219-W	Operaciones de Modificacion Meteorologica Destinadas a Incrementar la Precipitacion en Espana. Examen de la Precipitacion Recihida Durante el Periodo de 18 Meses Octuhre de 1952 a Marzo de 1954. By WRDC (Madrid).	August 1954.
224-A	Report on Hail Suppression Project, Mar. 21-June 21, 1954 (reference CA-2). For Placer County Farm Lahor Cooperative, California, by AIAR for WRDC.	September 1954.
225-A	Report on Cloud Seeding Operations, July 1953 to July 1954. For West Texas Utilities Co. (reference T-11 and T-12), by AIAR for WRDC.	October 1954.
226-A	Report on Cloud Seeding Operations, May 21-July 28, 1954 (reference ND-4). For North Central Weather Modification Corp., by AIAR for WRDC.	Do.
227-A	Review of Cloud Seeding Operations, October 1953-March 1954 (reference BC-2). For Powell River Co., Ltd., by AIAR for WRDC.	Do.
231-A	Review of Cloud Seeding Operations, August 26-Sept. 30, 1954 (reference: SD-6). For Custer County, S. Dak., by AIAR for WRDC.	November 1954.
228-A	Review of Cloud Seeding Operations, May-July 1954 (reference: SK-1, SK-2). For Weather Modification Cooperative, Ltd., and River Bend Modification, Ltd., by AIAR for WRDC.	Do.
229-A	Review of Cloud Seeding Operations, May 1-Aug. 14, 1954 (reference: MT-1). For Weather Modification, Ltd., by AIAR for WRDC.	Do.
230-A	Review of Cloud Seeding Operations, Apr. 18-Sept. 6, 1954 (reference: WY-8). For Laramie County Weather, Inc., Goshen County Weather Research Association, Niobrara County Weather Research Association, by AIAR for WRDC.	Do.
213-A	Review of Cloud Seeding Operations, Sept. 1, 1953-Apr. 30, 1954 (reference: W-3). For Pacific Power & Light Co., by AIAR for WRDC.	December 1954.
248-K	Weather Modification and Its Value to Agriculture and Water Supply. By Irving P. Krick. Paper given Mar. 4, 1954 by Dr. Krick before Royal Society of Arts, London, England (in form of reprints from April 1954 issue of Journal of the Royal Society of Arts).	March 1954.
236-W	A Study To Determine the Feasibility and Value of Cloud Seeding Operations in the Lebanon, Beirut, Lebanon. By WRDC.	December 1954.
234-A	Operations Report, Weather Modification Project, November 1954, Israel. By AIAR (confidential).	January 1955.
237-A	Hail Suppression Project, Mar. 31-June 21, 1954 (reference: CA-2), Supplement to Report No. 224. For Placer County Farm Labor Cooperative, California, by AIAR for WRDC.	Do.
238-A	Hail Suppression Project Report, Apr. 1-Oct. 15, 1954 (reference: O-5). For Rouge River Valley Traffic Association, by AIAR for WRDC.	Do.
232-A	Operations Report, October 1953 to October 1954 (reference: T-10). For city of Dallas, Tex., by AIAR for WRDC.	Do.
233-A	Operations Report, October 1953 to October 1954 (reference: K-2). For city of El Dorado, Kans., by AIAR for WRDC.	Do.
240-A	Operations Report Weather Modification Project, October 1954, Israel. By AIAR (confidential).	February 1955.
246-A	Interpretation of an Area Average Evaluation of the Effects of Cloud Seeding in Southern Utah. By Hales, Hoffer & Peck for Southern Utah Water Resources Development Corp. by AIAR (reference U-1).	Feb. 10, 1955.
243-A	Operations Report, Oct. 11-Dec. 11, 1954 (reference NC-1). For the city of Greensboro, N. C., by AIAR for WRDC.	March 1955.
242-A	Operations Report, Weather Modification Project, Israel, December 1954. By AIAR (confidential).	Do.
241	Report on Tignes Generator Locations (Weather Modification Project). For Electricite de France by AIAR.	To be published in near future.
250-A	Operations Report, Weather Modification, Project Israel, January 1955. By AIAR. Confidential.	
252-A	Increasing Streamflow and Power Production Through Weather Modification Operations. For Southern Services, Inc., Birmingham, Ala., by AIAR.	April 1955.
251-K	The Application of Weather Modification Techniques to Forestry Problems. By Irving P. Krick. Paper prepared for delivery before the annual meeting, gulf stream section, Society of American Foresters, Biloxi, Miss. May 26-27, 1955.	Do.
249-A	The Potential of Weather Modification Operations to the Banana Groves of the French Cameroon. For La Compagnie des Bananes. By AIAR.	Do.

A Bibliography on Weather Modification and Field Operations Using the Combined Facilities of Irving P. Krick Associates, Inc., American Institute of Aerological Research, Water Resources Development Corp., February 1957—Continued

Report No.	Title	Date
261-A	The Contribution of Cloud Seeding to Arid Land Economy. By Irving P. Krick and E. M. Frishy. Paper prepared for presentation before the AAAS, southwest section, at their annual meeting in Santa Fe, April 24-26, 1955. By AIAR.	April 1955.
257-A	Operations Report (reference: MO-1), Feb. 1, 1954-Jan. 31, 1955. For Springfield, Mo. By AIAR for WRDC.	Do.
263-A	Survey to Determine the Feasibility of Weather Modification Operations for the Lake Chapala and River Lerma Watersheds. For the committee of conservation for Lake Chapala, Guadalajara, Jalisco, Mexico. By AIAR.	May 1955.
262-A	Operations Report, Weather Modification, Project Israel, February 1955. By AIAR. Confidential.	Do.
268-K	Visible Evidence of Economic Benefits From 4 Years of Cloud Seeding Activities Over Southern Utah. Paper read by Boyd E. Quate at 158th National American Meteorological Society Meeting in conjunction with 36th Pacific Division American Association for the Advancement of Science Meeting. June 21-23, 1955. Pasadena, Calif. By Irving P. Krick.	June 1955.
247-A	Report of Cloud Seeding Operations for Lake Lytle, May and June 1955 (reference: T-14). By AIAR for WRDC.	Do.
267-A	Operations Report, Dec. 1, 1954-June 1, 1955. Reference: NV-2, Dec. 1, 1954 to June 1, 1955. NV-3, Jan. 1, 1955-June 1, 1955. For Nevada State Cloud Seeding Committee. By AIAR for WRDC.	Do.
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264-A	Operations Report, Weather Modification Project, Israel, Mar. 1955. By AIAR. Confidential.	May 1955.
268-K	Replaced by 271-A.	
271-A	Visible Evidence of Economic Benefits From 4 Years of Cloud Seeding Activities Over Southern Utah. Paper prepared for presentation before the American Meteorological Society, Pasadena, June 21-23, 1955, California Institute of Technology Meeting. By AIAR.	June 1955.
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273-K	A New Source of Underground Water. By Irving P. Krick, Ph. D., president of WRDC. Paper presented to the Vertical Turbine Pump Association, Dearborn, Mich., June 14, 1955.	Do.
265-A	Report on Weather Modification Operations in the Haut Katanga (Belgian Congo), January-April 1955. For Union Miniere du Haut Katanga. By AIAR for WRDC.	July 1955.
274-A	Comments on Report on Evaluation of Cloud Seeding Operations in Manitoba and Saskatchewan, Circular 2649, technical 215, May 2, 1955. By Warren L. Godson. For George G. Marler, Minister of Transport, Canada. By AIAR.	Do.
275-A	Operations Report, Weather Modification Project, May 15, 1954-May 15, 1955. For Southern Utah Water Resources Development Corp. (reference: U-1). By AIAR for WRDC.	August 1955.
276-A	Operations Report, Weather Modification Project, May 15, 1954-May 14, 1955. For San Juan Weather Improvement Association (reference C-11). By AIAR for WRDC.	Do.
277-A	Operations Report, Oct. 15, 1954-May 31, 1955 (reference: C-8). For Platte Valley Water Resources Association. By AIAR for WRDC.	Do.
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281-A	Summary Report on the Influence of Cloud Seeding During 1951-55 in the Upper South Platte River Basin. For the Denver Board of Water Commissioners. By AIAR (reference: C-8 supplement).	September 1955.
284-A	Precipitation Report C-14, July and August 1955. By AIAR for WRDC.	Do.
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266-A	Annual Report, Israel, July 1953-July 1954, Weather Modification Project. By AIAR Confidential.	September 1955.
291-A	Operations Report, Sept. 1, 1954-Apr. 30, 1955 (reference: W-3). For Pacific Power & Light Co. By AIAR for WRDC.	October 1955.
297-A	Operations Report, Oct. 1, 1954-Sept. 30, 1955 (reference: BC-2). For Powell River Co., Ltd. By AIAR for WRDC.	December 1955.
241-A	Published	April 1955.
295-A	Operations Report (reference: M-5), Sept. 1, 1954-Sept. 30, 1955. For Northwest Water Power Development by AIAR for WRDC. Administratively confidential.	November 1955.
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299-A	Operations Report (reference: QE-2), July 15, 1955-Sept. 15, 1955. For Laurentian Forest Protective Association, Ltd., by AIAR for Weather Engineering Corporation of Canada.	Do.
306-A	Interim Operations Report (reference: GA-1). For East Georgia Weather Modification Association by AIAR for WRDC.	Do.
310-A	Operations Report, Weather Modification Project, Israel, October 1955. By AIAR. Confidential.	Do.
307-A	Operations Report (reference: ON-1, Aug. 14-Nov. 30, 1955. For Abitibi Power & Paper Co., Ltd., by AIAR for Weather Engineering Corporation of Canada.	February 1956.
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293-W	Implications of Weather Control, an address given by Paul E. Ruch, vice president WRDC at the annual meeting of the Winnipeg Real Estate Board, Alexandra Hotel, Winnipeg, Canada, Feb. 2, 1956.	March 1956.
314-A	Operations Report (reference: T-13) Jan. 1-Dec. 31, 1955. For Mill Iron Ranches, Denver, Colo., by AIAR for WRDC.	Do.
315-A	Operations Report (reference C-13) Jan. 1-Dec. 31, 1955. For Mill Iron Ranches, Denver, Colo., by AIAR for WRDC.	Do.
316-A	Operations Report (reference: KY-1) Jan. 3, 1955-Jan. 2, 1956. For More Rain, Inc., Paris, Ky., by AIAR for WRDC.	April 1956.
319-A	Operations Report, Weather Modification Project, Israel, December 1955. By AIAR. Confidential.	March 1956.
317-A	Operations Report (reference: LA-1) Jan. 11, 1955-Jan. 10, 1956. For City of Shreveport, Department of Water and Sewage, Shreveport, La. By AIAR for WRDC.	April 1956.
320-A	Operations Report (reference: LA-2) Feb. 3, 1955-Feb. 8, 1956. For Red River Valley Water Resources Association, Inc., by AIAR for Irving P. Krick, Inc., of Texas. (Restricted.)	Do.
329-A	Review of Tucson Conference, Apr. 10-12, 1956, the Scientific Basis for Weather Modification Studies. Paper prepared by E. M. Frisby, M. A. director, Climatology AIAR, for American Meteorology Society meeting, May 14, 1956, Denver, Colo.	May 1956.
331-W	Weather Modification in Theory and Practice. By Irving P. Krick, Ph. D., president WRDC, Denver, Colo.	Do.
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333-A	Operations Report, Weather Modification Project, Israel, February 1956. By AIAR. Confidential.	Do.
330-A	Operations Report (reference: GA-1) Apr. 4, 1955-Apr. 16, 1956. For East Georgia Weather Modification Corp., by AIAR for Irving P. Krick, Inc., of Texas.	Do.
321-A	Report on Cloud Seeding Operations (T-10), Nov. 22, 1952-May 23, 1953, Oct. 12, 1953-Oct. 12, 1954, May 15, 1955-Feb. 29, 1956. For the city of Dallas, Tex., by AIAR for Irving P. Krick, Inc., of Texas.	April 1956.
337-A	Operations Report, Weather Modification Project, Israel, March 1956. By AIAR. Confidential.	June 1956.
334-A	Report on Cloud Seeding in the Upper South Platte River Basin (reference: C-8). For Denver Board of Water Commissioners by AIAR.	Do.

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335-A	Cloud Seeding To Supplement Municipal Water Supplies. For WRDC, by AIAR. (This report supersedes Rept. No. 331.)	June 1956.
338-A	Operations Report, Weather Modification Project, Israel, April 1956. By AIAR. Confidential.	July 1956.
336-A	Increasing Streamflow and Power Production in Brazos Basin by Means of Weather Modification Operation. For WRDC and Irving P. Krick, Inc., of Texas, by AIAR.	Do.
340-A	Operations Report (reference: FG-1) June 16, 1955-June 27, 1956. For Citizens Water Conservation Association, by AIAR for Irving P. Krick, Inc., of Texas.	September 1956.
343-A	Interim Report on Hail Suppression Operations July 20-Sept. 10, 1956 (reference: AL-1). For Knechill Hail Suppression Association, Ltd., by AIAR for WRDC Modification Corp., Ltd.	Do.
324-A	Weather Modification Operations To Increase Precipitation in Spain, Oct. 1, 1954-Sept. 30, 1955. For the Ministries of Agriculture and Air, Madrid, Spain by AIAR for WRDC, Madrid, Spain. (Also Spanish edition, same number.)	April 1956.
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327-A	Weather Modification Operations To Increase Precipitation in La Campiña de Córdoba, Spain, Sept. 1, 1954-Aug. 31, 1955. For C. E. P. A. N. S. A., Madrid, Spain, by AIAR for WRDC, Madrid, Spain. (Also Spanish edition, same number.)	Do.
332-A	Report on Cloud Seeding Operations (reference: T-10), Nov. 22, 1952-May 23, 1953, Oct. 12, 1953-Oct. 12, 1954, May 15, 1955-May 14, 1956. For the City of Dallas, Tex., by AIAR for Irving P. Krick, Inc., of Texas.	August 1956.
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339-A	Report on Hail Suppression Project (reference: CA-2), Mar. 25-June 25, 1956. For Placer County Farm Labor Cooperative, Inc., by AIAR for WRDC.	September 1956.
342-A	Operations Report May 23-July 5, 1956 (reference: T-13). For Mill Iron Ranches, Denver, Colo., by AIAR for Irving P. Krick, Inc., of Texas.	October 1956.
	Supplement to Report No. 332, Storm Analysis (reference: T-10), Apr. 28-May 2, 1956. For the City of Dallas, Tex., by AIAR for Irving P. Krick, Inc., of Texas.	Do.
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346-A	First Draft of Weather Modification Operations Report, 1955-56 (reference: N-3). For Cornhusker Weather Modification Association, Albion, Nebr., by AIAR for WRDC.	November 1956.
345-A	Operations Report, 1955-56 (references: W-1, W-2, O-6). For Horse Heaven Water Development Corp. (W-1 Big Bend Water Development Corp. (W-2), Morrow County Weather Research Association (O-6), by AIAR for WRDC.	Do.
347-A	Operations Report (reference: M-5), Sept. 1-Nov. 25, 1955, Nov. 28-Dec. 21, 1955, July 24-Aug. 31, 1956. For Northwest water power development project, by AIAR for WRDC. Restricted.	December 1956.
350-A	Report on Hail Suppression Project, July 20-Sept. 11, 1956 (reference: AL-1). For Knechill & Mountain View Hail Suppression Association, Ltd., by AIAR for WRDC and WRDC, Ltd., Calgary, Alberta, Canada.	Do.
351-A	Operations Report, October 1955-September 1956. For Powell River Co., Ltd. (reference: BC-2). By AIAR for WRDC.	Do.
349	Operations Report, May 25-Sept. 11, 1956. For Northeast Louisiana Water Resources Corp. (reference: LA-3), by AIAR for Irving P. Krick, Inc., of Texas.	Do.
353-A	Report on Hail Suppression Project, Apr. 1-Oct. 15, 1956. For Rogue River Valley Traffic Association, by AIAR for WRDC.	Do.
352-A	Weather Modification Operations Report, Oct. 15, 1955-Dec. 1, 1956 (reference: N-3). For Cornhusker Weather Modification Association, Albion, Nebr., By AIAR for WRDC.	January 1957.

(Whereupon, at 12:15 p. m., the hearing was concluded.)

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EXPERIMENTAL RESEARCH PROGRAM IN CLOUD MODIFICATION

HEARINGS

BEFORE A

SUBCOMMITTEE OF THE COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE UNITED STATES SENATE

EIGHTY-FIFTH CONGRESS

FIRST SESSION

ON

S. 86

A BILL TO PROVIDE FOR AN EXPERIMENTAL RESEARCH PROGRAM IN CLOUD MODIFICATION

MARCH 26 AND MAY 13, 1957

Printed for the use of the Committee on Interstate and Foreign Commerce

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[1] To succeed William A. Blakley, term expired, April 29, 1957.

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EXPERIMENTAL RESEARCH PROGRAM IN CLOUD MODIFICATION

TUESDAY, MARCH 26, 1957

United States Senate,
Committee on Interstate and Foreign Commerce,
Special Subcommittee on S. 86,
Washington, D. C.

The subcommittee met at 10 a. m., Hon. Alan Bible, chairman of the special subcommittee, presiding.

Senator Bible. The subcommittee hearing will come to order.

This is the time set for the hearing on Senate bill 86. I think it should be noted that between 1951 and 1953 congressional hearings on several bills introduced by members of both parties revealed that farmers, ranchers, electric utilities, municipalities, and other water users were paying somewhere between 2 cents and 20 cents per acre, and annually spending somewhere between $3 and $5 million on weather modification activities covering approximately 10 percent of the land area of the Nation. These legislative hearings showed that there was a necessity for an impartial evaluation of these extensive weather modification (cloud seeding) operations in order to ascertain if they were producing favorable or other results. There were no existing private or public agencies to perform this task. The existing agencies were primarily concerned with weather forecasting, pure and basic research in cloud physics, or commercial cloud seeding.

As a result of this lengthy congressional consideration, the Advisory Committee on Weather Control was established by the act of August 13, 1953. The life of the committee was extended with the same bipartisan support for an additional 2 years on July 9, 1956, Public Law 664, 84th Congress, because the Advisory Committee had been functioning, actually, for a period of only about a year and one-half due to the delay in obtaining initial appropriations and the difficulty in assembling a competent scientific staff to undertake this unique statutory assignment.

The bill which is now before us for consideration is S. 86, which provides for a $5 million 5-year cooperative Federal-State experimental research program in cloud modification to be conducted by the Advisory Committee on Weather Control, the States, their universities, and other agencies, and private institutions. This bill was introduced by Senator Case of South Dakota for himself and Senators Anderson, Magnuson, and Watkins. There are companion House bills, 3631, 5232, 5954, and 5958 introduced respectively by Congressmen Hull, Berry, Baring, and Engle.

Staff member assigned to this hearing: Harry C. Huse.

I will place in the record, and incorporated in full, Senate bill 86, which is now before this subcommittee for hearing purposes; also, a letter from Hon. Warren G. Magnuson, chairman of the Interstate and Foreign Commerce Committee, appointing this subcommittee.

(The matter referred to is as follows:)

[S. 86, 85th Cong., 1st sess.]

A BILL To provide for an experimental research program in cloud modification

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That, for a period of five years following the effective date of this Act, the Advisory Committee on Weather Control be authorized and directed to formulate a program of experimental research in the field of cloud modification with special reference to areas in the States that have suffered from shortage of natural rainfall.

SEC. 2. The experimental research program authorized by this Act shall be carried on either by contracts between the Advisory Committee on Weather Control and private or public agencies and through cooperative programs with State agencies, including land-grant colleges or other State agencies to be designated by the governor of the State.

SEC. 3. There is hereby authorized to be appropriated a sum not exceeding $5,000,000 for the accomplishment of the program herein authorized: *Provided,* That of the amount appropriated annually during the five years for which this program is authorized, one-fourth shall be available for that part of the program to be accomplished by contract and three-fourths shall be available for the cooperative program to be matched equally by the States.

SEC. 4. This Act may be cited as the "Cloud Modification Research Act of 1957".

MARCH 7, 1957.

Hon. ALAN BIBLE,
United States Senate, Washington, D. C.

DEAR SENATOR BIBLE: This is to inform you that I am today appointting you as chairman of a subcommittee to consider S. 86, to provide for an experimental research program in cloud modification.

The subcommittee is composed of the following: Senator Alan Bible, chairman, Senator Wm. A. Blakley, Senator Andrew F. Schoeppel.

Sincerely yours,

WARREN G. MAGNUSON, *Chairman.*

Senator BIBLE. Senator Case, I know of your great interest in this field, and the contributions you have made. The committee is fortunate in having you with us this morning as a witness on behalf of the legislation.

I might add that a request has been made of this committee to hold the hearings open for a short period of time in order to permit the departments to complete and file their reports, and the hearings will be kept open for that purpose for a reasonable period of time, 10 days or 2 weeks.

Since we haven't been regularly meeting we are very anxious to accommodate those witnesses who are here in Washington and here and ready to testify at this time.

Senator Case, it is proper and fitting that we first hear from you.

STATEMENT OF HON. FRANCIS CASE, A SENATOR FROM THE STATE OF SOUTH DAKOTA

Senator CASE. Thank you, Mr. Chairman.

I wish to express my appreciation for your going ahead with the hearings today in spite of the fact that the departmental reports are not completed as yet. There are some witnesses from out of town,

and I think it is a gracious accommodation to them to let them make their statements and presentations at this time.

Next, Mr. Chairman, I should like to express my personal pleasure at the fact that Chairman Magnuson of the Committee on Interstate and Foreign Commerce assigned this bill to this particular subcommittee. You come from a State which certainly has its own problems of marginal rainfall. I know of your interest in the subject.

Senator Blakley comes from Texas, where they have had outstanding problems of water shortage the past few years. Senator Schoeppel comes from Kansas, where although they may be having a little moisture now in the form of snow they have been experiencing some very severe problems which not only have affected agriculture, but also the communities of Kansas. I am pleased that Senator Carlson is here from Kansas to make a statement on the bill this morning.

With your permission, Mr. Chairman, I should like, first, to suggest 2 or 3 relatively minor amendments in the bill, and make a very brief statement, and then permit Senator Carlson and Congressman Baring to make their statements. I know they have other commitments during the forenoon, and I can complete mine later.

For the record, though, since you have introduced the bill into the record, I would suggest on page 1, line 10, the word "either" should be stricken, primarily for clarity, I think.

Then I should like to suggest a new section, following section 2, which would read as follows:

For the purposes of experimental program herein authorized, the Advisory Committee on Weather Control is authorized to accept contributions of materials or cash from States, associations, or persons desiring to make such contributions without reimbursement.

That obviously is merely to give them authority to accept contributions.

A somewhat similar proposal is in S. 84, but siuce S. 84 is limited to the Defense Department I thought it would be desirable to have this added here.

Then the succeeding sections 3 and 4 should be renumbered and possibly the commttee may want to extend the life of the Advisory Commttee in this bill.

As you have noted, the life of the Advisory Committee on Weather Control was extended by an act in 1956, but not as long as it would need to be in operation in order to carry on this 5-year program. Having mentioned that, and I think that suggests the amendments that I have in mind, the purpose of this bill, Mr. Chairman, is to take the next step in research in cloud modification. The Advisory Committee was given the responsibility of evaluating the experiments that have been carried no, or projects that have been carried on, either by private or public agencies, but the committee was not authorized to engage in field experiments. They have been concerned with assembling results of activities that have been noted by others, that led them to say in their report, which they submitted to Congress last year—the interim report—that certain results had been noted on the Pacific slope of the western mountains, but, whether or not those results could be applied, or those techniques could be applied, to the Great Plains region where we have the greater problem, perhaps, of water shortage, they were not in a position to say.

Growing out of that, I felt that we should have an experimental research program, a field experimental program, and this bill proposes methods of accomplishing that.

Now, then, if I may pause at this point, I should like to permit the Chair, if agreeable, to recognize the other Members of Congress.

Senator BIBLE. I am certainly happy to accommodate both Senator Carlson and Congressman Baring. I know each of you have other pressing engagements. If it is agreeable with you, I will recognize Senator Carlson.

STATEMENT OF HON. FRANK CARLSON, A SENATOR FROM THE STATE OF KANSAS

Senator CARLSON. I appreciate your courtesy in permitting me to be heard out of turn this morning.

I appear here this morning in regard to S. 86, the bill introduced by Senator Case on cloud modification. You can well understand that we in Kansas, as has been mentioned by Senator Case, not only Kansas, but several States in the Midwest, have suffered seriously from drought during the past few years, and when that situation prevails the citizens become desperate, they do not hesitate to spend money, they organize communities, they raise sums of money, and they have made every effort they could to try to secure some aid on relief through this type of program, and I think it is important that we try to get all the information we can on it for the future.

At the present I think it is generally agreed that there is much that we need to learn about this particular type of program. As has been mentioned, we have had some very fine moisture during the last 48 to 72 hours, and it is moisture that has fallen in areas where they have had practically no moisture for 4 to 5 years, which is really a very critical condition.

I say there is interest in it in Kansas. The Kansas Legislature is in session, and I have here before me house bill No. 39, which states:

An act relating to weather control and the artificial modification thereof; prescribing certain powers and duties to the State board of agriculture; creating a weather control commission and prescribing its powers and duties; providing for the licensing and registration of operators and for the collection and disposition of fees, and prescribing penalties for violation of the act.

This is a bill that has 12 separate paragraphs, 12 sections, which passed the House of Representatives on March 19 and is now in the Federal-State affairs committee of the Senate. I don't know what the final action will be, or when it will be, but it does in my opinion express interest in this type of program, and if there is no objection, Mr. Chairman, it might be of interest and might be of value to the hearing, and to the record that is being made, to have a copy of this bill made a part of the record.

Senator BIBLE. Without objection, that will be the order.

(House bill No. 39 is as follows:)

HOUSE BILL NO. 39

BY MR. BAUMAN

AN ACT Relating to weather control and the artificial modification thereof; prescribing certain powers and duties of the State board of agriculture; creating a weather control commission and prescribing its powers and duties; providing for the licensing and registration of operators and for the collection and disposition of fees, and prescribing penalties for violation of the Act

Be it enacted by the Legislature of the State of Kansas:

SECTION 1. For the purpose of determining the ultimate extent to which weather modification may be utilized in this State, and to assure proper safeguards, accurate information and data, the State board of agriculture and the State weather control commission are hereby vested with the powers and duties hereinafter set forth.

SEC. 2. As used in this act: (1) The word "board" means the State board of agriculture.

(2) The word "commission" means the weather-control commission.

(3) The word "person" means any individual, firm, association, partnership, organization, corporation, or municipality.

(4) The term "weather modification" means initiating, changing, or controlling the course or effects of the forces, measures and other factors constituting weather phenomenon including temperature, wind direction and velocity, and the inducing, increasing, decreasing, and preventing by artificial methods of precipitation in the form of rain, snow, hail, sleet, mist, or fog.

(5) The terms "experimentation" and "research and development" mean theoretical exploration and experimentation and the extension of investigative findings and theories of a scientific or technical nature in the practical application for experimental and demonstrative purposes, including the experimental producing and testing of model devices, equipment, materials and processes.

SEC. 3. The State board of agriculture shall administer and enforce the provisions of this act. The said board may, under rules adopted, delegate any of the powers and duties imposed upon it by this act to the secretary of said board and his assistants or subordinates and may authorize the said secretary or his assistants to perform any of the duties and exercise any of the powers, authority and jurisdiction conferred upon the said board by this act.

SEC. 5. There is hereby established a weather control commission which shall be composed of the secretary of the State board of agriculture, the chief engineer of the division of water resources of the State board of agriculture, and the dean of agriculture of the State college of agriculture and applied science, and two members to be appointed by the Governor. Said commission shall be an auxiliary of the State board of agriculture and shall be subject to the supervision of the said board. The commission shall meet quarterly on dates to be designated by the commission and upon the call of the Secretary of the State board of agriculture. The members of the commission appointed by the Governor shall receive ten dollars ($10) for each day or part thereof spent in the performance of their duties and shall receive actual traveling and necessary expenses incurred while attending the meetings. The secretary of the board shall give advance notice to the members of all meetings. Members of the commission appointed by the Governor shall hold office for term of one year, except that appointments to fill vacancies shall be made by the Governor for the unexpired terms. The commission shall annually elect a chairman and vice chairman from its membership and the secretary of the State board of agriculture shall act as secretary to the commission.

SEC. 5. The commission shall: (1) Determine the procedures, requirements, conditions, and professional standards under which licenses to conduct operations hereunder may be issued; (2) investigate and make recommendations to the board as to applicants who shall be issued licenses under this act; and (3) approve areas in which each operator is to work.

SEC. 6. The commission is further authorized and empowered: (1) To promulgate such rules and regulations as may be deemed proper and necessary to perform the duties imposed by this act, subject to the approval of the board; (2) to appoint qualified individuals or organizations to evaluate and publish the effects of all operations conducted within the State and to employ necessary clerical help, subject to approval by the board; (3) to recommend, after investigation, the revocation of licenses after proper notice and hearing; and (4) to enter into contracts or agreements as are necessary and as approved by the board.

SEC. 7. It shall be unlawful for any person to engage in activities for artificial weather modification except under and in accordance with a license issued by the board. Said board shall issue the license only upon the recommendation of the commission. Each license shall expire on December 31 of each year and shall be revocable prior to such date by the board upon recommendation of the commission in accordance with established procedures.

SEC. 8. Any person desiring to cause, or attempting to cause, condensation or precipitation of rain, snow, moisture, or water in any form contained in the

atmosphere, or shall prevent or attempt to prevent by artificial means the natural condensation or precipitation of rain, snow, moisture, or water in any form contained in the atmosphere, shall make application to the board in writing, on forms supplied by the board. Each application shall be accompanied by a registration fee of twenty-five dollars ($25). The license fee for each calendar year or fraction thereof shall be one hundred dollars ($100). Every licensee shall pay an additional annual fee of ten dollars ($10) for each generator installed and operated. The initial generator fee shall be paid within seven (7) days after such generator has been installed and placed in operation and thereafter no fees shall be refunded. Applications for renewal shall be made before March 1 of any year. Failure to pay any such fees shall be grounds for revocation of the license of the operator. No fee shall be charged for experimental or research work.

SEC. 9. All moneys collected under the provision of this act shall be deposited in the State treasury at least monthly and the State treasurer shall credit twenty percent (20 %) thereof to the general fund of the State and the remaining eighty percent (80%) shall be paid into a weather modification fund, which fund is hereby created and shall be used by the board for the administration of this act. The disbursements from this fund shall be made by warrants drawn on the State treasurer by the State controller upon vouchers approved by the secretary of the State board of agriculture.

SEC. 10. The board and the commission shall cooperate with the Federal Government and all agencies thereof and with the State agencies and with agencies of other States in conducting artificial weather modification operations.

SEC. 11. Any person who shall engage in any type of artificial weather modification without a license or who shall otherwise violate any of the provisions of this Act, shall be guilty of a misdemeanor and upon conviction shall be punished as provided by law.

SEC. 12. This Act shall take effect and be in force from and after its publication in the statute book.

Senator CARLSON. I might state again I think this is a problem that merits every consideration of this committee and the Congress, and I am indebted to the chairman and the members for giving me this time and giving me an opportunity to appear.

Senator BIBLE. Has there to your knowledge been any prior legislation passed in the State of Kansas in the cloud modification or cloud-seeding program?

Senator CARLSON. As far as I know, this is the first bill that has passed. We have had legislation introduced of various types. This is the first time that a bill of that coverage, with as complete coverage of all phases of it, has been introduced, in my opinion.

Senator BIBLE. Thank you, Senator Carlson. I know that you have many other commitments. We are pleased to have your statement.

Congressman Baring.

Senator CASE. If Senator Carlson is about to leave, Mr. Chairman, I wonder if I might exhibit to him and to you pictures of considerable interest.

This first picture taken last July in South Dakota shows the cloud formation at 12,000 feet. You will see it is a smooth undercast of clouds from the point at which this was taken, 12,000 feet.

The next picture shows two puffs appearing there; this is 20 minutes after dry ice was dropped into the clouds. After this 20 minutes you will note the two puffs of clouds have risen 800 feet.

At this picture, after 30 minutes, the two seeded clouds had formed large cells, and at 50 minutes the first cloud is now up to 18,000 feet. The C–47 they used couldn't climb fast enough to keep on top of it. There was rain that followed this seeding that averaged 3 inches down in the area of Sioux City, Iowa. Those pictures I think are of interest.

Senator BIBLE. They are, and the pictures will be kept for the information of the committee. I doubt if they can be conveniently made a part of the reporter's transcript, but they will be kept for our information.

Senator CASE. Here is another series of pictures which shows the use of different seeding techniques. This is status cloud clearing of an airfield at Presque Isle, Maine. The sequence of three pictures shows a fog cloud over the airfield, a strip through which the pattern of seeding was carried on, and then the hole in the fog cloud which cleared a path on the runway. This was taken in February of 1953.

Senator CARLSON. I think that is very interesting.

Senator BIBLE. We appreciate having these pictures for the record.

Thank you very much, Senator Carlson, for the courtesy of being with us.

Congressman Baring.

Mr. BARING. I, too, want to thank the committee for being given this opportunity to come before you. I do not come as a trained specialist on this, but I do have a short prepared statement as it affects our State, which I would like to read into the record at this time.

Senator BIBLE. You may do so.

STATEMENT OF WALTER S. BARING, A REPRESENTATIVE IN CONGRESS FROM THE STATE OF NEVADA

Mr. BARING. Mr. Chairman, on March 21, I addressed a letter to you on the subject of cloud seeding and weather modification activities conducted in northern Nevada, during the years 1951 through 1956 without Federal assistance. In that letter I pointed out a need for a scientifically designed and organized program of seeding over a long enough period of time so that the resulting data could be properly evaluated in the interests of both the local participants and the general public. I should like at this time to read my letter, to this committee, and to make it a permanent part of the record of these hearings:

Last month I received a letter from George B. Moseley, secretary-manager, Pershing County Water Conservation District of Nevada, directing my attention to the efforts of Mr. Edmund Muth, assistant State engineer, and chairman of the Nevada State Cloud Seeding Committee, toward the development of a cloud seeding and weather modification program in northern Nevada.

Upon receipt of this letter, I immediately established contact with Jack C. Oppenheimer, executive secretary, Advisory Committee on Weather Control. Through him, I have learned that tests were made in Nevada, under the direction of the Nevada State Cloud Seeding Committee, by the Water Resources Development Corp., and by the North American Weather Consultants, as follows:

May 1 through July, of 1951, in Elko County;

September 1951 to March 1952, in Elko County;

December 1, 1954, to June 1, 1955, in White Pine, Lincoln, and Nye Counties;

November 1, 1955, to May 30, 1956, in drainage area above Owyhee Dam and in the following counties: Humboldt, Pershing, Elko, Lander, and Eureka.

In addition, Joan Drackert, formerly manager of Pyramid Lake Guest Ranch, Sutcliffe, Nev., performed several tests.

These sporadic cloud seeding operations indicate a need for a scientifically designed and organized program of seeding over a long enough period of time so that the resulting data can be properly evaluated in the interests of both the local participants and the general public.

The Advisory Committee on Weather Control favors the principles contained in S. 86, introduced by Senator Francis Case of South Dakota, and, as they would administer the program, if the bill is enacted, they have expressed an interest in northern Nevada, which is a normal irrigation area, as an area which would provide data of scientific value. Accordingly, I have introduced H. R. 5954 as a companion bill to S. 86, and I feel that the proposed program would definitely benefit Nevada, as well as other Western States.

Under previously appropriated programs, the Advisory Committee on Weather Control has established that cloud seeding operations on the western slopes of the Pacific Coast States during the cooler and moist winter and spring months, have increased precipitation some 15 percent over that which would normally be expected. These conclusions are quite significant, but as yet they cannot be applied to other areas. Different climatic and topographical conditions that characterize experimental areas in northern Nevada, and other inland mountain areas, will produce certain physical problems that will require additional tests.

I understand that successful cloud seeding requires clouds which extend above the freezing level. The problem is to get the silver iodide smoke particles from the ground base generators up to these high levels, where they will be effective, without the aid of air-lifting slopes. Previous tests were successfully accomplished on the western mountain slopes only with this natural assistance. The Advisory Committee, I am also informed, is cooperating with the United States Forest Service in a program of research and evaluation in cloud seeding to diminish or suppress lightning. To the extent that this program may prove successful, the results may be applied to hail suppression operations, since conditions which produce lightning are similar to those which produce hail.

A study of tests made in Switzerland indicates that hail frequency has been reduced in those target areas. I have seen extensive distruction caused by hail throughout Nevada.

There is no weather modification program scheduled for 1957 in our State, and even though the law which established the Advisory Committee on Weather Control, provides that all experimental work, either private or Government, be reported to the Committee for proper evaluation and cataloging, the sporadic cloud seeding operations heretofore conducted in Nevada, have not provided conclusive scientific information. The Pershing County Water Conservation District of Nevada has requested that northern Nevada, which comprises Pershing, Humboldt, Lander, Eureka, and Elko Counties be included in such a program as is encompassed in S. 86, and since the conclusions and tentative observations resulting from western State tests cannot yet be applied to inland areas without further basic and applied research and experimentation of the kind envisioned by S. 86, I urge that this bill be reported favorably. I appreciate the opportunity to appear before this committee in behalf of S. 86.

On Friday, March 29, at 10 a. m., public hearings have been scheduled before the Health and Science Subcommittee of the House Interstate and Foreign Commerce Committee, to hear each Member of Congress who has introduced bills concerning weather legislation. I shall again appear before that committee in behalf of my bill H. R. 5954, which is a similar bill to the one we are considering today.

I thank you very much, and thank you, Senator.

Senator BIBLE. Thank you very much, Congressman Baring.

Do you have any knowledge of the results of these 6 or 7 tests that have been made in the State of Nevada?

Mr. BARING. I do not have them with me, Senator. I have heard about it, by ear, but I do not have the proof in writing.

Senator BIBLE. I have no doubt that Captain Orville will be able to clear up the point as to results of the tests in the State of Nevada, which I think, as you have testified, have numbered about seven different runs in the cloud seeding field.

Thank you very much. We appreciate your presence with us this morning. Senator Case, may we now hear from you?

STATEMENT OF HON. FRANCIS CASE, SENATOR FROM THE STATE OF SOUTH DAKOTA

Senator CASE. Mr. Chairman, probably it is a bit bold for a layman to venture observations with respect to this whole matter; yet, if I may recite a little of my observations and experience in this field, it will indicate why I have been interested in working on legislation of this type.

First of all, my interest grows out of the fact that in South Dakota we always find our crops conditioned by the weather. I personally grew up in the western part of the State, known as the short-grass country, where we might have been a little more conscious of moisture shortages than in the extreme eastern part. Last year we found that the drought area which had been largely in the southwest and moving on up toward Kansas, reach up and struck the most southeasterly counties in South Dakota for about the fourth year in a row. Where they normally raised abundant small grain and corn, they had a burned-up condition.

My interest in cloud seeding started back in the late forties, and took particular form, I think, in 1950, when I employed a plane to do a little experimental cloud seeding for a couple of trips. The results were rather dramatic—at least they seemed so to me—and the result of this experience was that I pressed for the legislation with other Senators, which you have mentioned, which created the Advisory Committee.

From a layman's point of view—and I emphasize that, because I know that there are scientists present, and their approach to this thing would be somewhat different. They will use different terms in making their observations, or whatever conclusions they may have reached. From a layman's point of view, cloud seeding falls into two main classes. First is the use of a ground generator using silver iodide particles, in an effort to have the silver iodide particles, as Congressman Baring has said, move upward into clouds and form nuclei for ice crystal to form, the effect that you have when you have a supercooled cloud, where the moisture precipitates in the form of frost crystals. When the crystals are large enough they descend through the warmer belts of air, becoming raindrops and fall as rain, or as snow, if it is cold enough for that.

You have a special set of cloud conditions on the west coast, where the Weather Advisory Committee has found fairly definite results obtained. You have a fog type of cloud, and the clouds are lower than they are in my country.

We, on the plains, don't have the high humidity or the low type of cloud, so the opportunities for cloud modification by using silver iodide generators are less frequent than they are where you have higher humidity and drifting fog clouds.

However, ground generators have been used, and there is a considerable record of the results obtained which will be presented by other witnesses. In the semiarid regions we have a great many cumulus clouds; locally we call them thunderhead clouds. My interest was attracted to finding some way to reach them, because you see them drift by. They may be quite high. Those pictures indicated the clouds were up to 12,000 feet. I have been interested in the possibility of getting something into those clouds that would carry them to whatever height was necessary to get the supercooled effect and to cause them to precipitate their moisture.

With silver iodide, when that is used, it is my understanding that it reduces the cold requirement, from about minus 30° centigrade to about minus 5, at which the precipitation will occur. To reach these cumulus clouds, we have experimented with aircraft.

I had hoped some time that if this program is authorized, that perhaps there will be experimentation by the use of rockets to reach some of those higher clouds.

In any event, last year we conducted this experiment, by use of jet aircraft. Joe Foss, our Governor in South Dakota, had told me some years ago that when he was flying at Guadalcanal they had used cloud seeding to clear some of the runways for planes to land there. He was convinced that there was something to this idea of cloud seeding, so with his cooperation last summer, we conducted some experimentation in seeding clouds, using jet aircraft.

The Advisory Committee, under its authority to cooperate with States, provided an adviser who gave valuable assistance in suggesting what clouds could be worked on, and under what conditions. On six different occasions the jet aircraft went up, and in each case their efforts were followed by precipitation.

When we made our first experiments in 1950, we used a conventional aircraft, just a small plane, which had difficulty in climbing to the altitude necessary. The boys at that time simply used a pasteboard carton with some dry ice in it, took a tea cup and tossed some chipped dry ice out of the window. It worked, but you couldn't do that with a jet aircraft, so last summer the boys in the National Guard who were working on this devised the idea of carrying a JATO tube on the belly of the jet aircraft. They put the dry ice in this tube and put a screen behind it, rigged it up with a foot peddle that the pilot could operate, and when they got over the cloud opened the JATO tube so that the wind would whistle through. They got the supercooling effect that was required.

They were quite startled, I think, by the way the clouds responded. With the jet aircraft they were able to stay on top of the cloud as it boiled up.

These pictures were taken when they went up first with a C–47, which couldn't climb fast enough to stay on top of the cloud as it rose. When the cloud gets up to eighteen or nineteen thousand feet, at least from experiments we have seen, you get precipitation. Of course, what we desire is to get more principles, more guidance, as to the conditions which are most favorable for cloud seeding operations.

Now, during the life of the Advisory Committee, they have made notable progress, I think, in evaluating what has been done. They submitted an interim report to Congress last year, and Captain Orville, the Chairman of the Committee, has been called upon since then to address meetings at various places in the country. The Farm Bureau Federation called on Captain Orville to speak at their annual convention at Miami, Fla., last fall.

The New York State Horticultural Society has asked him to appear there, and he has spoken there. Recently there was a meeting of the representatives of the land-grant colleges in four States at St. Joseph, Mo., where this subject was discussed.

The State of Texas has exhibited considerable interest. Louisiana, South Carolina, and other States, are showing an increasing interest in this whole subject. My own State of South Dakota, in the legislature which adjourned just a couple of weeks ago, passed legislation authorizing a $20,000 program in weather research, and part of it for cooperation with the Federal Government, should a program such as proposed by S. 86 be adopted.

Senator BIBLE. Who is the governing agency in South Dakota? Who has responsibility for the administration of the program?

Senator CASE. I am going to ask Dean A. M. Eberle to deal with that. Dean Eberle is the dean of agriculture of South Dakota State College, and also Vice Chairman of the President's Advisory Committee on Weather Control.

He was at the legislature at the time the details were worked out, and he is among the scheduled witnesses. I will not try to make his statement for him.

Senator BIBLE. You mentioned the first interim report of the Advisory Committee on Weather Control. Is that the report of February 1956, which you referred to?

Senator CASE. Yes; it is.

Mr. Chairman, I am going to make myself available for the members of the committee at any time during the time that you are working on this bill, and consequently I am not going to take more time now.

Senator BIBLE. Senator Case, I certainly appreciate your interest, and I want to extend to you a welcome to remain during this hearing, if your commitments will permit, because we do have a number of witnesses, and I know of your familiarity with the program, and you might desire to stay on and participate in the examination, if you care to.

Senator CASE. Mr. Chairman, if I mention some other responsibilities I have this morning, I am going to mention them merely to say that I think this hearing is more important. I could be at the Senate Armed Services Committee this morning for a meeting with the Joint Chiefs of Staff. I could be at the Public Works Committee at a hearing we are having on billboard advertising, but I personally feel that 50 years from today the people of that day will look upon what we may do in research into cloud modification and weather modification as the most important thing that was done in this session of Congress. Therefore I am going to stay here and get the benefit of the evidence that will be presented by these other witnesses.

92533—57——2

Senator BIBLE. We are certainly happy to have you remain with us, Senator Case.

(The following was submitted later by Senator Case:)

THE LIBRARY OF CONGRESS,
LEGISLATIVE REFERENCE SERVICE,
Washington 25, D. C., April 17, 1957.

Hon. FRANCIS CASE,
United States Senate, Washington 25, D. C.

DEAR SENATOR CASE. In response to your request of April 10, 1957, for the legislative history of weather modification (cloud seeding) we submit the enclosed report. In addition, we call your attention to the joint hearings before subcommittees of the Committees on Interior and Insular Affairs, Interstate and Foreign Commerce, and Agriculture and Forestry, United States Senate, 82d Congress, 1st session, on S. 5, 222, and 798, held March 14–16, 19 and April 5, 1951.

Sincerely yours,

ERNEST S. GRIFFITH, *Director.*

LEGISLATION RELATING TO CLOUD MODIFICATION

(Action indicated)

80TH CONGRESS

S. 2295: Introduced by Mr. Capper and referred to the Committee on Interstate and Foreign Commerce. To direct the Chief of the Weather Bureau to conduct experiments with respect to methods of controlling rainfall.

H. R. 4582: Introduced by Mr. Simpson of Illinois and referred to the Committee on Interstate and Foreign Commerce. Same title as S. 2295, *supra.*

81ST CONGRESS

S. 4236: Introduced by Mr. Anderson and referred to the Committee on Interstate and Foreign Commerce. To provide for the development and regulation of methods of weather modification and control.

H. R. 9579: Introduced by Mr. Case of South Dakota and referred to the Committee on Agriculture. To authorize the Secretary of Agriculture to conduct research and experiments with respect to methods of controlling and producing precipitation in moisture-deficient areas.

H. J. Res. 550: Introduced by Mr. Werdel and referred to the Committee on Rules. To create a joint congressional committee to study and investigate cloud nucleation.

82D CONGRESS

S. 222: Introduced by Mr. Anderson and referred to the Committee on Interstate and Foreign Commerce. To provide for the development and regulation of methods of weather modification and control.

S. 798: Introduced by Mr. Case and referred to the Committee on Agriculture and Forestry. To authorize the Secretary of Agriculture to conduct research and experiments with respect to methods of controlling and producing precipitation in moisture-deficient areas.

S. 2225: Introduced by Messrs. Case, Anderson, Cordon, Butler of Nebraska, Magnuson, Smathers, Lehman, Watkins, Ecton, and Young, and referred to the Committee on Interstate and Foreign Commerce, 97 Congressional Record 12737. To create a committee to study and evaluate public and private experiments in weather modification. Reported with amendments (S. Rept. 1514), 98 Congressional Record 5010. Remarks on, 98 Congressional Record 6282. Amended and passed Senate, 98 Congressional Record 7776. Referred to Senate Committee on Interstate and Foreign Commerce, 98 Congressional Record 7883. Reported back (H. Rept. 2360), 98 Congressional Record 8663. Objected to, 98 Congressional Record 8940.

H. R. 3672: Introduced by Mr. Stockman and referred to the Committee on Agriculture. Same title as S. 798, supra.

H. R. 4864: Introduced by Mr. Bolling and referred to the Committee on Interstate and Foreign Commerce. Same title as S. 222, supra.

H. R. 4887: Introduced by Mr. Horan and referred to the Committee on Interstate and Foreign Commerce. To authorize the Secretary of Commerce to provide for research and study, and, in cooperation with the States, to establish appropriate safeguards, with respect to weather modification operations and the problems related thereto.

H. R. 7325: Introduced by Mr. Poulson and referred to the Committee on Interstate and Foreign Commerce. Same title as S. 2225, supra.

H. R. 7785: Introduced by Mr. Smith of Mississippi and referred to the Committee on Interstate and Foreign Commerce. Same title as 2225, supra.

H. J. Res. 56: Introduced by Mr. Werdel and referred to the Committee on Rules. To create a joint congressional committee to study and investigate cloud nucleation.

83D CONGRESS

S. 285: Introduced by Messrs. Case, Anderson, Smathers, Magnuson, Lehman, and Butler of Nebraska. To create a committee to study and evaluate public and private experiments in weather modification. Introduced and referred to the Committee on Interstate and Foreign Commerce, 99 Congressional Record 256. Reported with amendments (S. Rept. 306), 99 Congressional Record 5631. Amended and passed Senate, 99 Congressional Record 6185. Referred to House Committee on Interstate and Foreign Commerce, 99 Congressional Record 6281. Reported with amendment (H. Rept. 1022), 99 Congressional Record 10434. Amended and passed House, 99 Congressional Record 10660. Senate concurs in House amendments, 99 Congressional Record 10780. Examined and signed, 99 Congressional Record 10957, 11156. Presented to the President, 99 Congressional Record 11023. Approved [Public Law 256], 99 Congressional Record 11102.

H. R. 1064: Introduced by Mr. Poulson and referred to the Committee on Interstate and Foreign Commerce. Same title as S. 285, supra.

H. R. 1584: Introduced by Mr. Horan and referred to the Committee on Interstate and Foreign Commerce. To authorize the Secretary of Commerce to provide for research and study, and, in cooperation with the States, to establish appropriate safeguards, with respect to weather modification operations and the problems related thereto.

H. R. 2580: Introduced by Mr. Smith of Mississippi and referred to the Committee on Interstate and Foreign Commerce. Same title as S. 285, supra.

84TH CONGRESS

S. 2913. Introduced By Messrs. Case of South Dakota, Anderson, Young, Barrett, Magnuson, Pastore, Mundt, Bricker, O'Mahoney, Kuchel, Watkins, and Hruska and referred to the Committee on Interstate and Foreign Commerce, 102 Congressional Record 363. To extend for 2 years the Advisory Committee on Weather Control. Reported (S. Rept. 1866) 102 Congressional Record 7029. Passed Senate, 102 Congressional Record 7267. Referred to House Committee on Interstate and Foreign Commerce, 102 Congressional Record 7321. Reported (H. Rept. 2424), 102 Congressional Record 10938. Passed House, 102 Congressional Record 11599. Examined and signed 102 Congressional Record 11902, 11923. Presented to the President, 102 Congressional Record 12150. Approved [Public Law 664], 102 Congressional Record 12244.

H. R. 10106: Introduced by Mr. Hosmer and referred to the Committee on Interior and Insular Affairs. To authorize the Secretary of the Interior to conduct cloud-seeding experiments in the Colorado River Basin.

H. R. 10336: Introduced by Mr. Engle and referred to the Committee on Interstate and Foreign Commerce. Same title as S. 2913, supra.

H. R. 10413: Introduced by Mr. Berry and referred to the Committee on Interstate and Foreign Commerce. Same title as S. 2913, supra.

85TH CONGRESS

S. 84: Introduced by Mr. Case of South Dakota and referred to the Committee on Armed Services. To be known as the Defense Cloud Modification Act of 1957.

S. 86: Introduced by Mr. Case of South Dakota (for himself, Mr. Anderson, Mr. Magnuson, and Mr. Watkins), and referred to the Committee on Interstate and Foreign Commerce. To provide for an experimental research program in cloud modification.

H. R. 2451: Introduced by Mr. Hosmer and referred to the Committee on Interior and Insular Affairs. To authorize the Secretary of the Interior to conduct cloud-seeding experiments in the Colorado River Basin.

H. R. 3631: Introduced by Mr. Hull and referred to the Committee on Interstate and Foreign Commerce. Same title as S. 86, supra.

H. R. 4638: Introduced by Mr. Berry and referred to the Committee on Armed Services. To provide a defense cloud modification program.

H. R. 5232: Introduced by Mr. Berry and referred to the Committee on Interstate and Foreign Commerce. Same title as S. 86, supra.

H. R. 5954: Introduced by Mr. Baring and referred to the Committee on Interstate and Foreign Commerce. Same title as S. 86, supra.

H. R. 5958: Introduced by Mr. Engle and referred to the Committee on Interstate and Foreign Commerce. Same title as S. 86, supra.

ELIZABETH ELWARD,
American Law Division.

STATEMENT OF CONGRESSMAN CLAIR ENGLE, ON BEHALF OF THE STATE OF CALIFORNIA

Mr. ENGLE. Mr. Chairman, I appreciate being invited to present a statement to this special subcommittee on S. 86, a bill to provide an experimental research program in weather modification. This legislation has my full support and I have introduced an identical bill in the House of Representatives.

The legislation authorizes a $5 million 5-year cooperative Federal-State research and experimentation program to be conducted by the Advisory Committee on Weather Control, the States, universities and other State agencies, and private institutions. It is my understanding that for the most part this program would be devoted to Federal-State cooperative efforts and financed by matching funds of the Federal and State Governments. In addition, a minor portion of the program would be accomplished by a contract between the Advisory Committee and public and private agencies and financed by Federal Funds.

Because of the initial favorable findings of the Advisory Committee on Weather Control, I sponsored, along with Senator Case, legislation in the 84th Congress to extend the life of the Committee, and this legislation was enacted. Now the next need is authority for this detailed research. Findings of the Committee to date have convinced me that this research program should be carried forward as rapidly as possible in order that we may have some definite conclusions with respect to what can be done in the way of increasing precipitation through cloud seeding activities.

In addition to this weather modification program I authorized the initial legislation and the amending legislation establishing the saline water program. With the water situation throughout the Nation becoming increasingly critical, I believe that we should conduct research in all fields that show promise of increasing our available water supply.

The Advisory Committee's statistical evaluations have established with a satisfactory degree of probability that cloud seeding operations in California and other Pacific Coast States during winter and spring months can produce average increases in precipitation up to 15 percent. To me this is very encouraging.

Extensive cloud seeding operations have been conducted in my district in California since 1950 for increasing irrigation and municipal water supplies, as well as making additional water available for

developing hydroelectric power. These operations have been conducted in the vicinity of Lake Almanor, in the Stanislaus-Mokelumne River watersheds, and in the Bishop and Placerville areas.

Other areas in California where cloud-seeding operations have been conducted are Santa Barbara, San Bernadino, Santa Clara, San Diego, and Kern Counties and the Kings River and San Joaquin River watersheds. These weather modification activities are all for the purpose of producing increased snow pack or rain.

A particularly interesting and significant weather modification activity is currently being conducted in Santa Barbara County in California. The department of water resources of the State has installed a dense network of recording rain gages throughout the county. The evaluation work is being conducted by the University of California. The United States Forest Service, the California State Forest Service, and the Advisory Committee on Weather Control are cooperating on the various research and evaluation aspects of this program. I believe that only by such carefully planned experiments designed to obtain the maximum amount of information can the definitive answers we need with respect to weather modification be obtained.

S. 86, if enacted, would provide that opportunity to extend research and experimental activities, such as those now being conducted in Santa Barbara County, to other areas of California and the Nation. This legislation should be enacted and I hope this committee will approve it.

Senator BIBLE. Our next witness is Colonel Corning, of the Air National Guard of South Dakota.

Is Colonel Corning here at the present time?

Senator CASE. We just received a wire from Colonel Corning that the weather made it impossible for him to get here today. He will be here tomorrow.

Senator BIBLE. I think that is a completely acceptable excuse. We will be glad to have him when weather does permit him to come.

It is rather significant, I believe, that these hearings are slated at a time when there is plenty of cloud modification in the drought States of our country.

We will hear Mr. Charles Smith, consultant to the Advisory Committee on Weather Control, of San Francisco, Calif. Do you have a prepared statement?

Mr. SMITH. Yes, sir, I have. I believe I furnished copies of it to the committee.

Senator BIBLE. Miss Reporter, after Senator Case's statement I would like to have included a statement from Congressman Clair Engle on this same legislation, if you will place it at that particular place in the record.

You may proceed, Mr. Smith.

STATEMENT OF CHARLES P. SMITH, CONSULTANT TO THE ADVISORY COMMITTEE ON WEATHER CONTROL, OF SAN FRANCISCO, CALIF.

Mr. SMITH. Mr. Chairman and members of this committee, first I want to express my appreciation for the opportunity to appear here today.

My name is Charles Pennypacker Smith. Since 1954 I have been privileged to serve the Advisory Committee on Weather Control as a consultant on technical matters. I am also employed, as supervising meteorological engineer, by Pacific Gas & Electric Co., 245 Market Street, San Francisco, Calif. For the past 5 years I have been in charge of experimental cloud-seeding projects in certain high elevation watersheds in the Sierra Nevada of California.

The Advisory Committee has established, beyond any reasonable doubt, that the relatively crude techniques now in use are capable of causing economically worthwhile increases in precipitation in the Western Mountain States. It is important to the Nation to determine, as quickly as possible, how and to what extent similar benefits can be obtained in other areas, especially those States which have experienced serious drought.

I am optimistic as to the possibilities. However, I share the view of many serious workers in the field that a carefully directed program of physical research is urgently needed. The proposed legislation offers the opportunity for the development of such a program. While this bill is aimed primarily at producing benefits for the drought States, the physical knowledge gained will be valuable to all.

The long sustained effort necessary to bring about successful results in the western mountain projects was possible only because of the environment of private enterprise. Working under the most difficult and discouraging conditions, a few pioneers persisted in supporting and operating these projects until success was attained. It is because of my great confidence that the Advisory Committee will preserve this favorable environment that I am able to give unqualified support to legislation which will continue to make available the resources of private enterprise essential to conducting experiments successfully in this field.

Senator BIBLE. Thank you, Mr. Smith.

I am wondering if you might, for the record, tell us of the successful results you did achieve in the Sierra Nevada, more specifically than your generalized statement. Why do you say they have been successful?

Mr. SMITH. Well, sir, we have three areas, three watersheds in the high elevations.

Senator BIBLE. You mean above what elevation?

Mr. SMITH. One of our projects is operating in the area above roughly 6,000 feet. That is in the central Sierras. That project has been underway for five winters.

Senator BIBLE. Where is that?

Mr. SMITH. The upper watershed, roughly to the southwest of Reno.

Senator BIBLE. And this is on the western slope?

Mr. SMITH. On the western slopes, yes. One of the projects is on the southeast side on the watershed that extends down to Lake Almanor, and the third is in a watershed northeast of Fresno, called Bass Lake.

Senator BIBLE. Each of these three projects are on the western slopes?

Mr. SMITH. That is correct. Except for the one on the southeast side of Mount Lassen, the ridge of the Sierras in that area lies to

the southwest of the target area, the target area being the area which we are attempting to improve the snow pack, and most of that watershed, practically all of that watershed lies on the east side, sloping down on the east side.

When we commenced this work, we anticipated correctly that it would require a great, long-standing effort, a number of years before we could successfully appraise the results, and this is what we have found.

Senator BIBLE. How many years have you been engaged—5 years?

Mr. SMITH. We have a maximum of 5 years; yes. Now, we feel that thus far the results look quite encouraging. One of our projects has been evaluated by the Advisory Committee, and the results appear to be roughly within the limits of the Advisory Committee's published statements as to effectiveness. However, we feel that quite a good many more years of operation will be necessary to really firm up any evaluation, and for this reason I am reluctant to name any figures, because this is something that can only be determined after you have enough years of operating experience to compare this with the many years of prior experience, during which many variable weather conditions occurred.

I can only say at this time that the results look positive, they look like they are within the limits of the Advisory Committee's report, and we are sufficiently encouraged to continue our own research and experimentation at our own expense.

Senator CASE. Mr. Chairman.

Senator BIBLE. Senator Case.

Senator CASE. If you will permit me, what was the limit in the Advisory Committee's report, up to 15 percent?

Mr. SMITH. That is the maximum limit in the report. I believe they are talking about 10 to 15 percent.

Senator CASE. Ten to fifteen percent increase in snow pack?

Mr. SMITH. That is right.

Senator CASE. I have a picture in my office, which I keep as an object lesson to our visitors, which shows some of the mountains on the western range there, and the peaks which are designated, or the areas which are designated as the target areas, show very definitely a heavier white cover of snow pack, as compared with some of the other peaks, or part of the mountain range which show bare, and the caption which is on the picture indicates that this is a visible evidence of the increased snow pack in the target areas.

Senator BIBLE. Your experimentation has been in snow pack?

Mr. SMITH. That is correct.

Senator BIBLE. Because of the elevation?

Mr. SMITH. That is right.

Senator BIBLE. Is this a generator operation or a plane operation?

Mr. SMITH. This is a generator operation. It is all done from ground base generators, and the operations are confined to the midwinter period from around the first of December—the earliest we have operated is the middle of November—and we always cease operations when we get into the late spring just prior to the opening of the fishing season, when people will be going into the mountains.

The areas in which this work is being done, where these experiments are being conducted, are areas, generally, the depth of the snow pack

makes inaccessible during the winter. We have confined our experiments to areas in which there is no human habitation in the winter.

Senator BIBLE. And do you think your cloud interception in California prevents those very fine heavy-laden clouds from coming on over into my State, Nevada?

Mr. SMITH. No, sir; there is no scientific evidence at all of any reduction in the rainfall in Nevada. In fact, it is just possible that there may be some improvement in the areas immediately downwind and across the Sierras.

Senator BIBLE. I might say, a year ago last December, when we had a disastrous flood, we would have been happy to intercept some of those clouds.

Mr. SMITH. For the record, let me state that we were not seeding at that time.

Senator CASE. Mr. Chairman, just one further question, if you will permit me.

Senator BIBLE. Certainly.

Senator CASE. The operations that you refer to are those that are initiated, conducted, and paid for by private-business corporations?

Mr. SMITH. That is correct.

Senator CASE. And they do it because they are interested in the commercial or the practical values that may be obtained?

Mr. SMITH. We are doing it because we believe that this offers an opportunity for perhaps a development of an important resource, important to the Nation. Naturally we would not do this unless we had hopes of making money at it.

Senator CASE. By increasing——

Mr. SMITH. Increasing the runoff in the winters during the summer months.

Senator CASE. Water for the production of power?

Mr. SMITH. That is right. In California, the runoff of the rivers occurs largely as a result of the melting of the snow pack laid down during the winter storms, so to the extent that this period of runoff can be extended, more hydro power can be generated, and just as important, more irrigation water can be made available to the farming community.

If, as a result of our experiments, the runoff in the rivers can be increased or lengthened, this makes the additional water available to the farming community without cost to them, because hydro power is a nonsumptive use of water.

Senator BIBLE. During the 5 years of experimentation, has Pacific Gas & Electric encountered any problems of legal liability?

Mr. SMITH. No; we haven't encountered any difficulty. We have endeavored to operate on a conservative basis so as to avoid that sort of thing, and we have had no difficulty.

Senator BIBLE. There has been no problem of that kind in that period of experimentation?

Mr. SMITH. That is correct.

Senator BIBLE. Thank you very much, Mr. Smith.

Congressman Hull, we are very happy to have you here, and will be glad to have you give us your testimony at this time, if you like.

Mr. HULL. Thank you, Senator Bible. I am sorry I am late this morning. It seems like we are always running a little behind time, for some reason or other.

STATEMENT OF CONGRESSMAN W. R. HULL, JR., FROM THE STATE OF MISSOURI

Mr. HULL. Mr. Chairman and members of the special subcommittee of the Senate Interstate and Foreign Commerce Committee, I appreciate this opportunity of appearing before your subcommittee in behalf of and in support of S. 86, and my companion bill, which I introduced on the House side, H. R. 3631, providing for an experimental research program in cloud modification.

My great State of Missouri has been experiencing one of the worst droughts in our history, along with a vast area throughout the Plains States. Too, it is a recognized fact that our water level has been disappearing at an alarming and rapid rate. It is certainly a fact that the water problem will be of major concern in the years ahead.

I do feel that the Federal Government has the responsibility to determine whether or not practical and definite economies will result from cloud seeding, as to proven facts resulting from reliable research, experiment, and study. The Federal Government has done much to control the floodwaters and rivers of this great country, and is constantly experimenting and studying methods to prevent these floods which have devastated our many areas. It has sought to rechannel and to provide irrigation where needed, and to harness and produce hydroelectric power.

The Federal Government has learned much, and the people of the United States have benefited greatly from these many projects.

I feel that our drought conditions are of paramount and equal importance. Too, I think that everyone should be vitally interested in our water problems, whether they come from the air or flow through our many streams, because most of our programs are planned and designed to alleviate disaster by taking advantage of our natural water resources with which this country is blessed, for the benefit of all of the people.

The same basic reasoning should be applied to the proposal for weather modification, or cloud seeding; for, if rainmaking is practical and controllable, certainly it should be and would be a much larger enterprise than could or ought to be taken by local groups.

This is especially true when our Government is spending millions upon millions of dollars for much-needed drought relief, and in many instances, as in my State of Missouri, has spent far too little, and has come too late to help our affected areas. The very enormity of this operation requires Government sponsorship to obtain the benefit from cloud-seeding areas, where needed, to prevent damage or disaster to areas that might be adversely affected. If cooperation is not fairly and closely supervised by Government operations, the experimentation being done by commercial firms is in many cases most unsatisfactory, and therefore conclusions drawn from these projects are of limited value.

Some experiments have been conducted in my home State of Missouri, but not on a large enough basis to arrive at any positive conclusions. Research, development, and study should be conducted on a basis that would permit evaluation of scientific data for all areas. There are vast areas needing more moisture, while other vast areas need less. Only this past year many areas of this great Nation suf-

fered from devastating rains and disastrous floods, while other sectors of our great Nation were in prolonged and devastating droughts. One is equally as bad as the other.

The scholar-statesman-scientist, Ben Franklin, proved that lightning is electricity, and to the great pleasure of past and present generations that electricity can be controlled. Franklin conducted this tremendous experiment with a key and a kite, the universal latchkey and a toy. What our great men of years ago dared and accomplished with trivial tools, gives us food for thought, with knowing they accomplished much, so why do we, who have such an abundance of technical knowledge and apparatus, hesitate to undertake a study that could be so rewarding?

I ask you to consider only one point: Would it not be worth all our efforts to eliminate the so well-known drought areas of these United States?

I certainly appreciate the opportunity of being before your committee this morning, Senator Bible.

Senator BIBLE. We appreciate your appearance very much, Congressman Hull. You have made a real contribution to our deliberations on this subject.

Senator CASE. I would like to express my personal thanks to the Congressman from Missouri for his very dramatic and effective statement. I know you, for one, have introduced a companion bill in the House, and I understand that hearings for that have been set for Friday.

Mr. HULL. Yes.

Senator CASE. At the outset of the hearings here, I made a suggestion for 2 or 3 relatively minor amendments, but one in particular I would like to call to your attention, one to incorporate a small section to authorize an advisory committee to receive contributions from public or private persons to augment the program authorized.

I hope, when you take up your bill in the committee, you might propose a similar amendment.

Mr. HULL. Thank you; I think that would be a very good amendment.

Senator BIBLE. Thank you, Congressman.

The next witness will be Mr. Eberle.

STATEMENT OF A. M. EBERLE, DEAN OF AGRICULTURE, SOUTH DAKOTA STATE COLLEGE, AND VICE CHAIRMAN OF THE PRESIDENT'S ADVISORY COMMITTEE ON WEATHER CONTROL

Mr. EBERLE. Mr. Chairman, my name is A. M. Eberle. I am dean of agriculture at South Dakota State College, and I am also Vice Chairman of the President's Advisory Committee on Weather Control.

I have been connected with South Dakota State College for the past 35 years. I started my work as a county agent, was an extension marketing specialist, Director of the Agricultural Extension Service, and since 1939 have been dean of agriculture. I believe I know the State's agriculture and its problems.

I know the agricultural problems of the State, and I have gone through the drought problems of the thirties, where I was director

of the drought-relief programs in South Dakota. I have been actively connected with weather modification, or cloud seeding, since 1951, when farmers in my State contracted with private seeders to increase the rainfall.

Prior to that, as Senator Case has mentioned to you, he carried on some preliminary work that really brought on the interests of our people in the State, so we started really actively in 1951.

I might say for the record, that it was in about 1953, when the State of South Dakota was thinking about passing some sort of a law regulating the seeders, or the operators who were coming into our State, and in 1955 we had a law passed that licensed operators through establishing of a South Dakota Weather Modification Commission, and they are not only licensed to come into the State, but after they are in, and counties accept their services, then they have to come to the commission once more to get permission to operate in those counties. That prevents duplication or competition amongst operators for the same counties.

Senator BIBLE. Of what is this commission composed?

Mr. EBERLE. Two members are appointed by the Governor, and the other three members are the State secretary of agriculture, the State water resources commissioner or engineer, and the dean of agriculture.

Now, this session of our legislature which just adjourned, as was mentioned by Senator Case, revised that bill, and enlarged the commission, because now it will carry on research work of its own, and the commission is enlarged to include 5 members of the State plus 3 I mentioned, the secretary of agriculture, the engineer, and the dean.

At the same time, it made a small appropriation—the Senator said $50,000. I would like to say it was cut, in the final analysis, to $20,000, and that in itself is quite a victory for South Dakota, when you think of the struggle that our legislature had relative to the tax problem. They cut out many worthwhile activities because of shortage of money, and then put in this new one, because they were sold on the idea that we should do something in this whole problem of weather modification, so it was really a victory, and was well received by a great many people of the State.

Senator CASE. Mr. Chairman, if you will permit me to say at that point, it was a victory—the victory was attributed to Dean Eberle, and to the intelligent and consistent interest he has shown in this subject. He has worked with the members of the legislature, and with the farmers of the State, and they have a great deal of confidence in his opinions.

Mr. EBERLE. I would also like to say at this point that I am very sorry that Colonel Corning or Governor Foss couldn't come. Two weeks ago they were getting read to come here. Both of them had this actual experience in cloud seeding with dry ice, which Senator Case mentioned to you last spring, and they were very enthusiastic about the results.

Senator BIBLE. We hope they can join us before the hearings are closed.

Mr. EBERLE. At our institution we evaluated the work of the operators as best we could, and have constantly advised with farmers relative to this important work.

South Dakota had at one time 12 million acres under contract with private cloud seeders. The 4-year summary made by State College

of the seeding operations showed a 9 percent increase in rainfall over that which would have fallen naturally. It was difficult to get a good correlation, because all areas did not seed the same length of time. The result would have been higher had the seeding dates been the same for all areas. The correlation was very difficult, but that was the best we could arrive at.

In the Great Plains a considerable number of studies have indicated that, in the case of spring wheat, 1 inch of precipitation, above the 5 to 10 inches, is associated with a yield increase of 1.5 to 3.5 bushels per acre. We can figure that the ratio of increase in yield to increase in precipitation is about 2 to 1 over a base of a minimum of 8 inches, or, in other words, 1 inch of rainfall will yield 2 bushels of wheat. Over most of the Great Plains the annual average precipitation is so close to the amount required for growing grain crops that the sizable natural fluctuations in precipitation are of extreme significance. All of the cloud seeding in South Dakota has been done in the spring. We are finding that fall seeding has gerat possibilities. Increasing the fall rainfall means storing water in the ground and building up the subsoil moisture. If this is done consistently year after year, it will have a real effect in minimizing any prolonged drought period.

I think we are probably all agreed, because of favorable movement of our clouds and cold fronts in the fall, that we could increase moisture in the fall. The only objection that farmers have is that it might snow them in, in the winter, but I believe that they are thinking in different terms than we were a year or so ago.

The Advisory Committee on Weather Control has indicated in their first interim report that, under certain conditions, cloud seeding works. Capt. Howard Orville, Chairman of the Committee, will testify as to the findings of the Committee.

I would like to direct my comments toward S. 86, which provides for an experimental research program in cloud modifications. I would say that our knowledge of the seeding of clouds to increase precipitation, or for hail and lightning suppression, is about at the same stage as the Ford car was in 1920. A great deal more must be learned about the precipitation processes. This knowledge must be gained by conducting field experiments under controlled conditions and under the direction of highly qualified scientists. This experimental work should be done both by the Federal Government and by the States.

We should keep in mind, however, the fact that we do not have to start from the beginning. We already know a great deal about weather modification. The private operators have something like a half million hours of seeding experience. They have a great deal of information that I know they will be only too willing to make available. This information can be used primarily for applied research or field experimental research.

Much of this type of research can bring almost immediate results, and can reflect in solving some of the drought problems. Then there are problems I would call basic, problems that will give us information that can be used in the applied research as soon as it is available. It is my thought that we cannot wait for all these answers; one must find them to be sure, and, as we do, make use of them. In the meantime, let us go ahead with what we know, and by experiment add to

our present knowledge, if it is good, and if we find it is not, then we can disregard that phase of our investigation.

If it can be made to work in the drier, flatland areas of this country, the returns will result in many times the cost of experimentation and operation and will stabilize those areas that are intermittently dry and wet.

In the Great Plains area, if successful, it will mean taking the entire series of States out of the so-called semimarginal and marginal belt.

I firmly believe that the work from the Federal angle should remain in the hands of the Advisory Committee on Weather Control, for the following reasons:

1. Since weather modification research and experimentation should be pushed as rapidly as possible, this Committee is in a better position to fulfill this need than any existing agency.

It has a well-trained staff of scientists, and they have been spending all their time studying, advising, and carrying on cooperative projects with other agencies. It is their main and only job.

2. They are in a position to evaluate research projects as they are submitted by both the governmental and State agencies, and because of their specialized training and the fact that their entire thinking is in this field and will not be interrupted by other details, they can coordinate and direct a most excellent nationwide research program.

3. To turn this work over to another existing agency would mean slowing down the investigational process, and it eventually could come to a point of elimination. Some agencies of Government could not accept this added responsibility without changing the law under which they operate. This would be difficult to do, and not required if the Committee on Weather Control is continued. All agencies of Government have about all they can do, and I personally know some of them that find it difficult to handle what the Congress has charged them by law to do now.

The Advisory Committee on Weather Control is a very active and a going concern, and ready to immediately get into gear and spend their entire thoughts and energy to a sound research and experimentation on weather control.

I am not in any way reflecting on the work or abilities of any Federal group or agency. I am saying that I want to again emphasize the fact that the Advisory Committee on Weather Control is a very active and going concern. It was brought into being in August 1953. It got underway some time in 1954 and in this short time has done a marvelous and remarkable piece of work. It would be a very serious mistake to turn this work over to another agency and practically lose the continuity of the program and the results of many projects that are nearing completion.

Senator BIBLE. Thank you very much, Dean Eberle.

Roughly, what is the average rainfall in the State of South Dakota?

Mr. EBERLE. Well, it varies a great deal with east to west. Probably down in the southeast corner it would be 20 to 24 inches. Up in the northwest corner of our State, outside of the particular little hill sections, we get down to 8 or 10 inches.

Senator BIBLE. And in those areas, down to 8 to 10 inches, do I understand that the cloud-seeding experiments, which have been car-

ried on over the past 4 or 5 years, resulted in a 9-percent increase in that rainfall?

Mr. EBERLE. Yes, that is right; 9 percent. That would not be only in the extreme northwest corner, but also in the central part of the State. It is about 14 to 15 inches.

Senator BIBLE. And there, too, it has been increased by 10 percent?

Mr. EBERLE. Yes; a little more than an inch of rain through cloud seeding. That is as close as we can come to it.

Senator BIBLE. I realize the difficulty in evaluating it.

Senator CASE. Mr. Chairman, I want to again indicate my personal appreciation to Dean Eberle for coming here and making his statement. I want to ask: Isn't it true that one of our problems in cloud modification in South Dakota is the variability of the clouds? In some seasons and some years we have conditions which would seem to be more favorable to cloud modification than others.

Mr. EBERLE. Yes; that is absolutely right, Senator. Particularly during the summer we are lacking of clouds. We do not have many, but I think the favorable season for seeding in our State is in May and June, particularly, and if we could increase the rainfall in that time it would help a lot and carry us through the July period.

Senator CASE. I am interested in what you say about the fall seeding and the fear of farmers of being snowed in. If we were to seed in the earlier part of the fall before the ground has frozen, and before we would have enough cold weather that the snow would stay on the ground, we might get some pretty good results, or usable results?

Mr. EBERLE. I believe that is correct.

Senator CASE. Even if you got it in the form of snow, if the weather was warm enough so it would thaw in a few days, we would get maximum benefit.

Mr. EBERLE. That is correct; and our operator has been doing that this fall. They didn't get started early enough because the contracts weren't completed, but by next fall we will be able to do that.

Senator CASE. I recall one season when two different commercial groups were seeding, and there was no coordination between them as to the seeding operations. There was a feeling on the part of some people that the overlapping, perhaps, had bad results rather than good results.

Now, is it your feeling that, in a research program such as this proposes, that the Advisory Committee could supervise and coordinate it so that we wouldn't be working at cross purposes, so to speak?

Mr. EBERLE. Oh, I definitely feel that is correct. If there is coordination between the Federal Government and the States, and the States have small appropriations, we can have someone take charge which we haven't had in the past. Under the bill that was just passed by us in South Dakota, 10 percent of the money goes for administration, so we could have somebody who would coordinate the activities of the State and Federal Government along that line.

Senator CASE. You definitely feel, do you, Dean, that this is one case where it is something that the Government can do better than private individuals, particularly in supervision and in basic research?

Mr. EBERLE. I am satisfied on that, in supervision and basic research. There will have to be research done by the States, because

each one has peculiar problems, as you mentioned, with movement of clouds, and so forth.

Senator BIBLE. Thank you, Dean Eberle.

The next witness will be Thomas J. Henderson, of Bishop, Calif. Mr. Henderson.

STATEMENT OF THOMAS J. HENDERSON, CHIEF HYDROGRAPHER, CALIFORNIA ELECTRIC POWER CO., RIVERSIDE, CALIF.

Mr. HENDERSON. Mr. Chairman and members of the committee, my name is Thomas J. Henderson. I am chief hydrographer for the California Electric Power Co., Riverside, Calif., and president, Weather Control Research Association, Los Angeles, Calif.

The Weather Control Research Association was organized informally in 1951, and adopted a constitution and bylaws in 1954. Article II: Purpose, of this constitution states:

> The purpose of the organization shall be to provide an opportunity for individuals and organizations interested in weather-modification problems from any viewpoint to meet and exchange information for their mutual benefit. The organization shall also be committed to the following:
>
> (*a*) Encourage scientific research in the investigation of weather modification.
>
> (*b*) Coordinate efforts of different weather-modification projects.
>
> (*c*) Promote an exchange of weather-modification information.
>
> (*d*) Encourage standardization of weather-modification recording procedures.
>
> (*e*) Encourage and promote a high degree of professional conduct on the part of those engaged in weather modification.
>
> (*f*) Render technical assistance to the formulation of legislation pertaining to weather modification.
>
> (*g*) Encourage and promote the scientific evaluation of weather-modification results.

We have had about 14 meetings of this association since its formation. During three of those meetings we have had statements from representatives of the Advisory Committee on Weather Control. The statements made by that Committee concerning their investigation have substantiated our belief that cloud-seeding programs can and have resulted in economical precipitation increases in some of the Western States areas.

The progress and success of weather modification in these areas has resulted from the persistent belief of private industries that this science has a firm foundation and a promising future. However, in all meetings it has become increasingly apparent there is much need for further laboratory and field research. Recent drought conditions in this country indicate that such research is doubly needed.

Legislation which will promote such research, both in the laboratory and in the field, and which supports the purposes of the Weather Control Research Association, has our support.

I would like to add that I have been connected with the weather-modification program of the California Electric Power Co. since its beginning on February 2, 1948. This has been a more or less continuous annual program since that time, and was designed to increase precipitation in a small target area on the eastern side of the Sierra Nevada Mountains in California. I believe this is the longest continuous experimental cloud-seeding program in the world. The first 3 years of the program were analyzed by the United States Weather

Bureau, and the results published by the Department of Commerce in Research Paper No. 36.

The California Electric Power Co. holds a corporate membership in the Weather Control Research Association and supports the policies of that organization.

Senator BIBLE. Who are the members of the Weather Control Research Association? How do you determine its membership?

Mr. HENDERSON. The membership is determined simply by anyone who is interested in weather-modification problems. We have about 40 members, individual members. About 10 or 12 are corporate members. They represent not only private industry, but Federal organizations, too, in the West.

Senator BIBLE. Do individual farmers belong to the organization?

Mr. HENDERSON. That is true.

Senator BIBLE. And certain power companies?

Mr. HENDERSON. That is true; Pacific Gas & Electric, Southern California Edison, and there are some in Washington and Oregon, too.

Senator BIBLE. It is purely a volunteer association?

Mr. HENDERSON. Yes; it is.

Senator BIBLE. What, in a few words, are the results of that weather modification which you have been engaged in since 1948?—you say it is the longest continuous program.

Mr. HENDERSON. The California Electric Power program, you mean?

The analysis that the United States Weather Bureau made of the first 3 years of the operation indicated a 9 percent average annual increase in those 3 years, and they have not publicly brought that analysis up to date in the rest of the years following those first 3 years, but we looked at it and the results look about the same to us.

Senator BIBLE. It has been in continuous operation since 1948?

Mr. HENDERSON. February 2, when we made our first flight; yes, sir.

Senator BIBLE. And the small areas are in the neighborhood of Bishop?

Mr. HENDERSON. Yes; on the Bishop Creek watershed. That we consider our target area. It is very small, and encompasses only about 30 square miles.

Senator BIBLE. Is this a snow-pack modification?

Mr. HENDERSON. Yes; it is. About the first 4 years it was on a seasonal basis, October through March. But since that time we have put it on an annual basis, and attempted to increase rainfall in the summer also.

Senator BIBLE. With what success?

Mr. HENDERSON. We think that 9-percent figure is about right.

Senator BIBLE. You believe that is an overall safe figure as to seed modification over a period of 9 years—you have increased the rainfall-snow pack by approximately 9 percent?

Mr. HENDERSON. Well, the analysis was figured in terms of annual streamflow, instead of snow pack, but that is the figure that applies to the streamflow, and I think that is a pretty good average annual figure.

Senator BIBLE. It has held consistently up at the 9 percent?

Mr. HENDERSON. It has varied around that figure. In 1 or 2 years the result appeared to be negative, but in most of the years it was positive, and the average is about 9 percent.

Senator BIBLE. Is this a plane operation?

Mr. HENDERSON. Yes, it is; with dry ice.

Senator BIBLE. Have you tried generators in that area?

Mr. HENDERSON. No; we don't think it is feasible because of the wind direction from the west. We would have to put the generators in very rough locations, very difficult to get to.

Senator BIBLE. Do you know if there is any legislation on the statutes of California on cloud modification, governed by some overall agency?

Mr. HENDERSON. The only legislation that is in effect in California that I know of at the present time is the one which requires licensing of all cloud-seeding activities in that State. That is a pretty general bit of legislation, and only requires you to have a license, and to submit reports to the department of water resources.

Senator BIBLE. You secure licenses from the aeronautical agency, or from the water resources department?

Mr. HENDERSON. We receive the license from the water resources department.

Senator BIBLE. Thank you, Mr. Henderson.

Senator Case.

Senator CASE. Mr. Chairman, I appreciate the privilege and the opportunity to ask a few questions of Mr. Henderson. I think he has presented a very interesting statement here.

Mr. Henderson, are you personally in charge of the modification program as carried on by the California Electric Power Co.?

Mr. HENDERSON. Yes, sir; that is correct. I might add that I am in charge of the field operations, the actual operations of it.

Senator CASE. Have you flown in the planes during the seeding operations?

Mr. HENDERSON. Yes; I flew on every flight for 2 years.

Senator CASE. What altitude do you seed there?

Mr. HENDERSON. We have been seeding with dry ice at the cloud-top elevation, whatever that may be, and that has varied all the way from 17,000 feet up to as high as 32,000.

Senator CASE. I think that is a most interesting activity. Under what conditions of humidity do you find the best results; or are your results related to humidity in our area?

Mr. HENDERSON. I think they probably are, though we don't make humidity measurements from the airplane. We have found that the best results, of course, come from clouds that seem to be very wet, but we make no humidity measurements from the airplane, so I cannot really say.

Senator CASE. You don't plan to go up so many days a week, but so far as your cloud opportunities present themselves?

Mr. HENDERSON. The operation is on a standby situation all of the time, and we depend on observations to tell us when we should go up, just by looking at the clouds.

Senator CASE. And the California Electric Power Co. has been paying for this program, itself?

Mr. HENDERSON. Yes; they have.

Senator CASE. And having carried it on for 9 years they think that the results, in terms of knowledge and precipitation, has justified them in continuing it?

Mr. HENDERSON. Yes; they feel that, although nothing has been proved as to whether or not we are actually paying for the program in terms of water, but they are so enthusiastic about the possibilities that they have been willing to continue this thing.

Senator CASE. That is all, Mr. Chairman.

Senator BIBLE. Thank you, Mr. Henderson.

The next witness will be Capt. Howard T. Orville.

We are glad to have you with us, Captain Orville.

Captain ORVILLE. I am pleased to be here, sir.

STATEMENT OF CAPT. HOWARD T. ORVILLE, USN (RETIRED), CHAIRMAN, ADVISORY COMMITTEE ON WEATHER CONTROL

Captain ORVILLE. Mr. Chairman, I would like to insert in the record the letter which has just been received from our office, addressed to the chairman of the Senate Interstate and Foreign Commerce Committee, which gives the report from the Committee, sir.

Senator BIBLE. The letter will be inserted in the record.

ADVISORY COMMITTEE ON WEATHER CONTROL,
Washington, D. C., March 26, 1957.

The Honorable WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
United States Senate, Washington, D. C.

MY DEAR MR. CHAIRMAN: This is in reply to your letter requesting comments on S. 86.

The Advisory Committee on Weather Control is in favor of the objectives of Senate bill S. 86, a bill to provide for an experimental research program in cloud modification. The Advisory Committee, in its first interim report to President Eisenhower on February 8, 1956, strongly recommended the development of a long-range program in basic and applied research in cloud physics under scientifically controlled conditions. The program outlined in S. 86 and House companion bills H. R. 3631 and H. R. 5232, contains the desirable features of a scientifically controlled program of the type outlined in the first interim report.

During the past 6 months the serious drought conditions have been the occasion for an increasing number of proposals and inquiries from the Congress and other sources to the Advisory Committee on Weather Control regarding the urgent need for starting a Federal-State research and experimentation program of cloud seeding. This interest has been demonstrated from all parts of the Nation by farmers, ranchers, electric utilities, States and municipalities, foresters, and other water users concerned with rain and snow increasing and hail and lightning reducing. At the request of State and local officials, representatives of the Advisory Committee have attended meetings regarding its study and evaluation of weather-modification activities and the local water and drought problems involved in such States as Arizona, California, Florida, Nevada, Oregon, South Dakota, Texas, and Utah.

Officials of such States as South Dakota, Florida, and Texas have suggested Federal-State programs, and are in the process of organizing the State portions of such programs. These State programs will utilize the facilities of the State universities, State water-resources agencies, and funds from private foundations and industry. It is understood that plans for similar organization are underway in Utah.

The members of the Advisory Committee on Weather Control are unanimously in favor of a cooperative Federal-State basic and applied research program of the nature contemplated by S. 86, H. R. 3631, and H. R. 5232 which would be based on findings and program recommendations made by the Advisory Committee. However, the committee decided to ascertain from its six Federal agency

members expressions of their interest and as to which would be the most appropriate agency to undertake the administratiou of the Federal portion of the program. On this point there is a differeuce of opinion among the agency members of the Advisory Committee who have thus far responded, which can be seen by the attached copies of their letters on the matter.

The Department of Agriculture expresses a preference for the National Scieuce Foundatiou to assume the major responsibility for developiug aud coordinating the long-range program, making maximum use of the skills and facilities that may exist in other departments. The Departmeut of Health, Education, and Welfare believes that if the program objectives are to be accomplished primarily through research grants and contracts with universities and other research organizations, the National Science Foundation is well equipped to administer the activity. But should proposed legislation contemplate direct operations at the Federal level, including coordination of field investigations, the interest of other member agencies should be considered. The Department of Commerce regards its bureaus as directly interested and qualified to administer the program. However, it recognizes the similar interests of other departments and the desirability of establishing arrangements for interdepartmental cooperation in any large-scale research undertaking in weather modification. This agency also emphasizes the importance of placing the planning and administration of weather modification research under the immediate supervision of highly competent scientist-administrators.

The National Science Foundation expresses a definite interest in present and future basic research in the general area of weather modification. It is its view, that by far the most important element toward progress in weather modification is a better understanding of the precipitation process and the special conditions which may give promise of more effective techniques, since evidence to date seems to indicate clearly that no large or important effects will be produced by present means without such knowledge. For these reasons, it feels that it would seem to be misleading and wasteful of money and effort to embark upon operational or even developmental plans in the expectation of achieving practically important results. It would be contrary to Foundation policy to conduct or support a general plan in cooperation with the States, or in any other manner, aimed at development of practical means for weather modification, or at operational plans for proceeding toward this end. However, the Foundation would, if requested, consider taking the lead among Federal agencies in establishing and carrying out a general plan for research toward a better understanding of the subject, with the expectation that the interested agencies would cooperate and participate in carrying out such plans for practical development as might arise.

I believe these agency views on the appropriate organizational iustrument to administer the Federal responsibilities under the research and experimentation program conteuplated by the bill are very helpful. They emphasize the need for basic research of the kind which the National Science Foundation is uniquely equipped to sponsor. On the other hand, they point out the need for Federal interagency administratiou where the program involves the interests of more than oue agency, the coordination of field iuvestigations, the development of practical means for weather modification, and direct Federal operations. We believe that it should be possible in the near future to present administration recommendations, but at present there is no agreed-upon position.

In this connection we wish to point out that the Advisory Committee on Weather Control does not now have the legislative authority to engage in a program of research and experimentation. Ou the other hand, the Advisory Committee is the ouly agency currently authorized and, in fact, carrying out studies and evaluations of weather modification experiments, supervised by competent scientist-administrators, which are essential components of such a program.

In closing, we would like to draw to your committee's attention that in January of this year the President personally inspected conditions in the drought-stricken States. As a result of this inspection trip and a simultaneous conference of local interests and State and Federal agencies on drought and other natural disasters in Wichita, Kans., the President sent a special message to the Congress on March 5. Among many other recommendations of the Wichita conference emphasized by the President in his message is research relating to weather. S. 86, if enacted, would authorize a Federal-State cooperative research program in weather modification.

The Bureau of the Budget has advised that there is no objection to the transmittal of this report.

Sincerely yours,

HOWARD T. ORVILLE, *Chairman.*

DEPARTMENT OF AGRICULTURE,
Washington, D. C., March 5, 1957.

Mr. JACK C. OPPENHEIMER,
Executive Secretary, Advisory Committee on Weather Control,
Washington, D. C.

DEAR MR. OPPENHEIMER: In response to your request of February 19, 1957, we are glad to indicate the Department's viewpoint with respect to the future site of responsibility for research in the field of weather control.

We believe that development of knowledge in this field will require initiation and prosecution of a long-range research program which should be the responsibility of established Federal agencies. Our preference would be that the National Science Foundation assume the major responsibility for developing and coordinating such a long-range program, making maximum use of skills and facilities that may exist in other departments of the Government. The Department of Agriculture will be pleased to cooperate with the National Science Foundation and others wherever appropriate in the development and execution of such a program.

Sincerely yours,

E. T. BENSON, *Secretary.*

THE UNDER SECRETARY OF COMMERCE FOR TRANSPORTATION,
Washington, March 5, 1957.

Mr. JACK C. OPPENHEIMER,
Executive Secretary, Advisory Committee on Weather Control,
Washington, D. C.

DEAR MR. OPPENHEIMER: In reply to your letter of February 19 to Government members of the Advisory Committee on Weather Control, I would like to reaffirm comments made in Committee meetings from time to time stating the continuing interest of the Department of Commerce in administering and participating in research programs in cloud physics and possibilities of weather modification. Several of the bureaus of this Department have direct interest in this subject. In view of the similar interests of other departments, it is desirable to set up arrangements for interdepartmental cooperation in any large scale research undertaking in weather modification.

One of the bureaus directly interested in cloud physics and weather modification is the Weather Bureau. The principles involved in this rsearch are closely related to weather forecasting. New knowledge in weather modification may bring new or modified techniques in weather forecasting. Moreover, when silver iodide or other materials, introduced artificially into the atmosphere, are effective in changing the weather, these factors must be taken into account in weather forecasting.

The implications of cloud seeding demonstrated by Langmuir and Schaefer about 10 years ago led this Department to carry on extensive field tests from 1947 through 1954. Among the projects were seeding experiments in Ohio and California, the ACN program in the State of Washington, and analysis of numerous field experiments by other agencies and individuals. These tests showed conclusively that further basic research is necessary in order to reach definite conclusions about weather modification. Some of these studies are now in progress.

Sporadic seedings without sound design and technical controls during recent years have brought conflicting information and obscured the way to real progress. Further field experiments without well coordinated scientific guidance are not likely to bring answers to questions about the practical possibilities and consequences of weather control. For this reason, I emphasize the importance of placing the planning and administration of research in weather modification under the immediate supervision of highly competent scientist-administrators who can best design and conduct this important research program.

Sincerely yours,

LOUIS S. ROTHSCHILD.

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE,
Washington, March 5, 1957.

DEAR MR. OPPENHEIMER: This is in reply to your communication of February 19, 1957, transmitting for comment a resolution adopted by the Advisory Committee on Weather Control at its meeting on February 13, 1957.

This Department concurs in principle with the three-point statement adopted by the Committee from the Chairman's memorandum of January 2, 1957. We understand this statement is to be used to guide the committee staff in the event further legislation is considered.

It is the view of our technical staff that the greatest immediate need in weather modification is for sound research in cloud physics to develop a better understanding of the basic principle involved in the precipitation process. For a long-term program of this type it would seem desirable to place the administrative responsibility in an established Federal agency.

If the program objectives are to be accomplished primarily through research grants and contracts with universities and other research organizations, the National Science Foundation is well equipped to administer the activity. On the other hand, should proposed legislation contemplate direct operations at the Federal level, including coordination of field investigations, the interest of other member agencies should be considered. We do not believe the Department of Health, Education, and Welfare should be considered to assume the responsibility for this program.

Sincerely yours,

M. B. FOLSOM, *Secretary.*

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
Washington, D. C., March 8, 1957.

Capt. HOWARD T. ORVILLE, USN (Retired),
Chairman, Advisory Committee on Weather Control,
Washington, D. C.

DEAR CAPTAIN ORVILLE: This is in reply to the letter dated February 19 from the Executive Secretary of the Advisory Committee on Weather Control.

First, let me say that the National Science Foundation has a definite interest in present and future basic research in the general area bearing on the subject commonly known as weather modification. This is directed primarily to fuller knowledge and better understanding of the natural processes which give rise to producing or inhibiting precipitation. As a Federal agency, in view of the practical importance of the subject of weather modification, the Foundation believes in full encouragement and stimulation to competent work in science relating to this general subject. Our present program in support of basic research already includes support of special research projects in this area.

It is my view, both from the evaluative activities of the committee and from the consideration given to the subject in the Foundation, that by far the most important element toward progress in weather modification is discriminating support of work on fundamental problems in competent hands dealing with the study of the precipitation process both under controlled laboratory conditions and in nature. Evidence to date seems to indicate clearly that no large or important effects will be produced by present means without a better understanding of the precipitation process and the special conditions which may give promise of more effective techniques. For these reasons, it would seem to be misleading and wasteful of money and effort to embark upon operational or even developmental plans in the expectation of achieving practically important results.

Insofar as the National Science Foundation may be involved in future planing, it would be contrary to Foundation policy to conduct or support a general plan in cooperation with the States, or in any other manner, aimed at development of practical means for weather modification, or at operational plans for proceeding toward this end. In accordance with its established policy, however, the Foundation would, if requested, consider taking the lead among Federal agencies in establishing and carrying out a general plan for research toward a better understanding of the subject. In that event, the Foundation would expect assurances of cooperation from their interest and willingness to participate in carrying out such plans for practical developments as might arise.

Sincerely yours,

ALAN T. WATERMAN, *Director.*

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., March 15, 1957.

DEAR MR. OPPENHEIMER: The Department of the Interior has a definite interest in any and all work which affects water resources. We have followed with interest the experimental work being done in the weather-modification field. In answer to your letter of February 19, I wish to make the following comments:

It is the opinion of qualified persons in this Department that the status of weather modification is such that the greatest need lies in better understanding the physical principles involved in the precipitation process. We recognize that at an appropriate time there is also the need for well controlled large-scale cloud-seeding experiments, but we believe that research in cloud physics is at the present time of highest priority.

Research of this kind requires a long-term program. Members of the Department of the Interior believe that a long-term program of investigations can best be prosecuted by one of the established agencies of Government. The Advisory Committee on Weather Control will render a real service through its efforts to analyze and evaluate the available data, and to recommend the types of work necessary in the field of weather modification. It is logical that the administering Federal agency would be guided by the results of the evaluations and the recommendations made by the present Advisory Committee. However, I presume that the language of item 3 in the Committee's policy statement I quoted in your letter does not impose on the administering agency a specific program developed by the Committee: rather, the Committee's findings would furnish background and ideas for the formulation of a program.

The Department of the Interior does not wish to assume the responsibility for this program, though the effect of weather modification might have an important influence on the Department's operations. The investigations and the research which we believe are needed will probably be done to a great extent by universities, research organizations, and the United States Weather Bureau, where there are persons qualified to do such work. Thus, future work will to a great extent be accomplished through research grants-in-aid. Therefore, for the administration of such a program, we recommend the National Science Foundation, a scientific bureau experienced in weighing research proposals and allocating Federal funds for research purposes.

Sincerely yours,

HATFIELD CHILSON,
Acting Secretary of the Interior.

Captain ORVILLE. Then, Mr. Chairman, if I may, I would like to introduce a letter received from the head of the department of meteorology of the Massachusetts Institute of Technology. In this letter he has expressed his views on the possibilities of cloud modification, and his views on S. 86.

Senator BIBLE. That is from whom?

Captain ORVILLE. Prof. Henry G. Houghton, from the Massachusetts Institute of Technology.

Senator BIBLE. Is he is a member of the Advisory Committee?

Captain ORVILLE. He is a consultant to the Committee; not a member.

Senator BIBLE. That letter may be made a part of the record.

Captain ORVILLE. He was unable to get here because of important commitments at Cambridge this week.

Senator CASE. I think Dr. Houghton is one of those who testified at the time the original legislation was passed.

Captain ORVILLE. That is true.

Senator CASE. Is his letter in support of S. 86?

Captain ORVILLE. It is; this letter is in support of S. 86, and outlines his views.

Senator BIBLE. It appears to be a rather short letter. Certainly there is no objection to having it read, if you wish?

Senator CASE. Dr. Houghton is recognized as one of the great scientists in this field. I would be interested in knowing what he says.

Senator BIBLE. I think you might well read it.

Captain ORVILLE (reading):

This is in reply to your letter of January 24, 1957, requesting comments on S. 86, a bill to provide for an experimental research program in cloud modification. The views expressed are mine as an individual and not necessarily those of my institution.

I am a firm believer in the need for research on the precipitation mechanism and, to the extent that this is contemplated under S. 86, I am in favor of it.

There are two ways to advance our knowledge of cloud modification. One is the empirical approach in which a long series of randomized cloud-seeding experiments is evaluated statistically. The other avenue is to concentrate on the dynamics and cloud physics of the precipitation process with the aim of acquiring a more complete and quantitative understanding of the natural precipitation process. These two approaches are complementary, and I would favor research along both lines.

It would be prohibitively expensive to conduct statistical experiments in all regions of the country. We must depend on the cloud-physics approach to provide the ultimate quantitative basis on which it will be possible to preselect suitable areas for the exploitation of cloud seeding. We can also anticipate that this will lead to suggestions for improved and novel methods of weather modification.

My major concern about S. 86 centers around section 2. It is not clear to me what agency is to supervise the contracts supported, in part, by the matching funds from the States.

In many of the water-poor States there is relatively little present competence in cloud physics. Without adequate professional advice such States could conceivably undertake unsound projects.

Further, to insure against unnecessary duplication and to foster exchange of information, an agency such as yours should have some overall jurisdiction. This does not seem to be spelled out in section 2.

In my opinion there is no strong reason for establishing an experimental cloud-seeding program in Massachusetts. There is only sporadic public interest in this field coincident with our occasional summer dry spells.

At MIT we would be more interested in research on the natural precipitation process. Although there are many problems relating to the microphysics of cloud and precipitation, we feel that it is now essential to study the mesoscale dynamics of precipitation systems as they affect the initiation and growth of precipitation particles. The best tool for this purpose is radar, and we have developed special competence in this area.

If we are to participate in the research program envisaged under S. 86, our present feeling is that our most effective contributions would be along these lines.

Sincerely yours,

HENRY G. HOUGHTON.

Senator BIBLE. Thank you, Captain Orville.

Captain ORVILLE. If I may, I should like to read a statement which I have prepared.

Senator BIBLE. Yes; we have been furnished copies of that statement, and you may read it into the record.

Captain ORVILLE. My name is Howard T. Orville, chairman of the Advisory Committee on Weather Control. I am associated with the Friez Instrument division of Bendix Aviation Corp. at Towson, Md., in Baltimore County, and devote approximately one-third of my time to Advisory Committee duties.

It is a pleasure to appear before this committee to make a statement on Senate bill S. 86, a bill to provide for an experimental research program in cloud modification. My remarks in the following paragraphs represent the views of the Committee, except in certain

instances where I will give my personal opinion, and in those instances it will be clearly indicated that they do not represent the views of the Advisory Committee.

Before commenting on Senate bill S. 86 may I briefly review the composition of the Advisory Committee and its accomplishments during the past 2 years. This comment will serve to give you a better understanding of my comments on the various provisions of S. 86.

THE ADVISORY COMMITTEE

After more than 2 years of exhaustive hearings by the Congress, the Advisory Committee on Weather Control was established by Public Law 256, 83d Congress, on August 13, 1953. The Committee consists of 11 members, 6 from interested Government departments and 5 from among persons in private life of outstanding ability in science, agriculture, and business. The present membership is shown by the following roster:

MEMBERS FROM PRIVATE LIFE

Howard T. Orville, captain, USN (retired), Chairman; technical consultant, Friez Instrument division, Bendix Aviation Corp., 1400 Taylor Avenue, at Loch Raven Boulevard, Baltimore 4, Md. Phone: Valley 3–4040.

A. M. Eberle, Vice Chairman; dean of agriculture, South Dakota State College, Brookings, S. Dak. Phone: 701.

Lewis W. Douglas, member; Southern Arizona Bank & Trust Co., Tucson, Ariz. Phone: Main 2–7411. Also, chairman of the board, Mutual Life Insurance Co., 1740 Broadway, New York 19, N. Y. Phone: Judson 6–4000.

Joseph J. George, brigadier general, USAFR, member; superintendent of meteorology, Eastern Air Lines, Atlanta, Ga. Phone: Poplar 7–0221, extension 53.

Kenneth C. Spengler, member; executive secretary, American Meteorological Society, 3 Joy Street, Boston 8, Mass. Phone: Capitol 7–1881.

MEMBERS FROM GOVERNMENT

Department of Defense:

William M. Holaday, Deputy Assistant Secretary of Defense, Research and Engineering, 3–D–137 the Pentagon, Washington 25, D. C. Phone: Liberty 5–6700 (code 131), extension 79101

Earl G. Droessler (alternate). Phone: Liberty 5–6700 (code 131), extension 74197

Department of the Interior:

(Vacant), Washington 25, D. C. Phone: Republic 7–1820 (code 155)

Luna B. Leopold (alternate). Phone: Republic 7–1820 (code 155), extension 3580

Department of Agriculture:

Ervin L. Peterson, Assistant Secretary of Agriculture, Washington 25, D. C. Phone: Republic 7–4142 (code 161), extension 3306

Theodore C. Byerly (alternate). Phone: Republic 7–4142 (code 161), extension 5213

Arthur A. Brown (observer). Extension 2809

Department of Commerce:

Louis S. Rothschild, Under Secretary of Commerce for Transportation, Washington 25, D. C. Phone: Sterling 3–9200 (code 164), extension 600

F. W. Reichelderfer (alternate). Phone: Adams 2–3200 (code 1252), extension 201

Department of Health, Education, and Welfare:

LeRoy E. Burney, the Surgeon General, Washington 25, D. C. Phone: Executive 3–6300 (code 176), extension 2461

Mark D. Hollis (alternate). Phone: Executive 4–6300 (code 176), extension 4281

John H. Ludwig (observer), 47 Carey Avenue, Boston 72, Mass. Phone: Watertown 4–2247

National Science Foundation:
Alan T. Waterman, Director, Washington 25, D. C. Phone: Sterling 3–2140 (code 1224), extension 3644
Paul E. Klopsteg (alternate), 828 Apple Tree Lane, Glenview, Ill. Phone: Sterling 3–2140 (code 1224)

SENIOR STAFF MEMBERS

Capt. F. A. Berry, USN, Chief Scientific Adviser, 227 Winder Building, Washington 25, D. C. Phone: Executive 3–4900 (code 156), extension 5231 or 5232
Gerald D. Berndt, climatologist, Washington 25, D. C. Phone: Executive 3–4900 (code 156), extension. 4342 or 4343
Jack C. Oppenheimer, Executive Secretary, 227 Winder Building, Washington 25, D. C. Phone: Executive 3–4900 (code 156), extension 5231 or 5232

Captain ORVILLE. The members from private life were appointed by President Eisenhower on December 9, 1953, and confirmed by the United States Senate on January 25, 1954.

The Advisory Committee held its first meeting on December 18, 1953, and since that time has been actively engaged in making—

a complete study and evaluation of public and private experiments in weather control for the purpose of determining the extent to which the United States should experiment with, engage in, or regulate activities designed to control weather conditions

WORK ACCOMPLISHED

Since December 1953 the Committee has made and is continuing a very careful study and evaluation of all aspects of weather modification—cloud seeding

Because of budgetary and technical staffing problems the full evaluation program could not be placed in operation until January 1955. Funds were not available until July 1, 1954, and the temporary status of the Committee made it difficult to get highly qualified technical personnel to accept appointments to the staff.

However, after the initial starting difficulties were overcome, the evaluation proceeded smoothly and rapidly to produce results of greatest importance to weather modification.

Copies of the reports giving these results have beeen made available to your committee and are listed in an appendix to this statement.

The highlights may be briefly summarized:

1. The Committee has held 15 meetings. Public Law 256 requires only 2 meetings annually, each about 6 months apart.

2. Received more than 300 technical reports for review from domestic and foreign cloud-seeding companies, corporations, and individuals.

3. Consulted with or sought the advice of nearly every outstanding scientist in the world familiar with one phrase or another in the field of cloud physics and weather modifications.

4. Been briefed at regular intervals on Government-sponsored research projects.

5. Made numerous field trips to observe at firsthand cloud-seeding operations, to talk to groups of farmers and other clients in drought-stricken areas, and to review the competence of persons carrying out cloud-seeding operations. These trips have been especially valuable in giving the members an understanding of the farmers' and ranchers' problems.

6. Established a program of evaluation projects—some projects already completed—to study all phases of cloud modification. See appendix for list of these projects.

7. The Committee has recently encouraged and successfully guided the establishment of a 3-year randomized weather modification research project in Santa Barbara County, Calif. This project is jointly sponsored by local, county, State and Federal agencies, as well as State universities and private cloud-seeding companies.

8. After an analysis of over 5,000 storms, it has shown statistically that cloud seeding has produced an average increase of 15 percent over natural precipitation in the Pacific Coast States.

Senator BIBLE. What do you include in the Pacific Coast States?

Captain ORVILLE. Washington, California, and Oregon, and applies particularly to the mountainous areas, and to the late spring storms, later winter and early spring storms, where you have a deep cool airmass coming into the mountainous areas, and applies to projects analyzed, extending over a period of 3 to 5 years.

The results cannot be extrapolated to other areas of the country. This does not mean that cloud seeding did not work in other areas, but the Committee has not been able to officially establish increases in the interior Mountain States, or in the flatlands, such as the Great Plains States.

9. Has received substantial photographic evidence of cloud modification on cumulus and supercooled stratus clouds when seeded with dry ice or silver iodide. Recently, a task force of the Committee observed a snowstorm caused by silver iodide seeding in the high Sierras. An estimated one-half inch to three-quarters inch of snow fell.

10. It is my pleasure to inform this committee that reports received from Australia continue to indicate that aircraft seeding is producing increases in precipitation of 30 to 33 percent.

In Japan, reports received from the Meteorological Research Institute inform us that rainfall was increased about 40 percent.

Reports received from France and Formosa indicate increases in precipitation on the order of 15 to 20 percent over that which would be expected from natural causes.

All of these reports do not state specifically whether or not the above increases are statistically significant. And I want to emphasize that point.

This suggests that increases in precipitation, in some cases, must be determined by methods other than statistical. Radar, silver iodide generators, and special rain-gage networks in the target area may be required to determine the effects of cloud seeding.

This record of accomplishments has been possible because some of the Committee members and its small but highly qualified staff have been able to concentrate with absolute minimum of interference from outside sources on the study and evaluation directed by the Congress.

Capt. Frederic A. Berry, USN, our chief scientific adviser, and Mr. Jack C. Oppenheimer, executive secretary, are present here with me today to answer further technical or administrative questions, if you so desire.

Senator BIBLE. We would be happy to have Captain Berry and Mr. Oppenheimer join you at the table.

Captain ORVILLE. At the conclusion of my paper, Captain Berry can show you some of the results which we have obtained as a result of our study.

Senator BIBLE. Both men are invited to come up to the witness stand.

Captain ORVILLE. Comment on Senate bill S. 86.

The members of the Advisory Committee have expressed approval of a long-range basic and applied-research program in cloud modification. Several members would prefer to retain this program within the complete supervision of the Federal Government and to direct primary attention to basic research.

The majority of the Government members recommended that the National Science Foundation be designated to carry out this research program. Some, however, have stated that this agency should be given essentially the same authority that the Advisory Committee on Weather Control now has.

This latter precaution is probably based on the very important need for coordination and cooperation between the local, county, State, and Federal agencies in order to avoid duplication and to insure continuity in the present evaluation now being conducted by the Advisory Committee on Weather Control.

In response to a resolution adopted unanimously by the Committee at its 15th meeting, February 13, 1957, asking the six Federal agency members for expressions of their interest and as to which would be the most appropriate agency to undertake the administration of the Federal portion of the program, the Committee has received reports from each of the departments.

Copies of these letters are attached to the report which was submitted for the record to the Honorable Warren G. Magnuson, chairman of the Interstate and Foreign Commerce Committee of the United States Senate.

I believe these agency views on the appropriate organizational instrument to administer the Federal responsibilities under the research and experimentation program contemplated by the bill are very helpful. They emphasize the need for basic research of the kind which the National Science Foundation is uniquely equipped to sponsor.

On the other hand, they point out the need for Federal interagency administration where the program involves the interests of more than one agency, the coordination of field investigations, the development of practical means for weather modification, and direct Federal operations.

Senator CASE. Did you tell us how many members there are from Federal agencies?

Captain ORVILLE. Six; appointed by the Secretary of the agency.

Public Law 256 states that the Secretary of the department, or his designee, shall serve as a member of this Committee. The agencies are the Departments of Defense, Agriculture, Interior, Department of Health, Education, and Welfare, the National Science Foundation, and the Department of Commerce.

Senator CASE. And how many are appointed from private life?

Captain ORVILLE. There are five members from private life.

Senator CASE. There are altogether 11 members?

Captain ORVILLE. Eleven members.

The Committee decided at its first meeting, since many of the Government members are of the sub-Cabinet level, and are, of course, very busy men, that it would be desirable for each of them to have an alternate member, so each of the Government members has an alternate serving, and these alternate members are constantly informed of the workings of the Committee. In fact, they have been very active in formulating the policies and helping the Committee.

Senator CASE. I wonder, for the purpose of interpreting this paragraph in your statement, if you would distinguish between basic research and field experimentation?

Captain ORVILLE. Basic research is the type that is conducted without any direct knowledge of where you may be going. It covers the wide field of the subject of cloud physics, without any design or guided objective, whereas the applied research is conducted specifically to improve known methods and to expand the knowledge of some definite facts which we know something about, but do not have complete knowledge.

Senator CASE. Would you say it is somewhat comparable to going from the laboratory to a pilot plant, if we were speaking in terms of metallurgy, or something of that sort?

Captain ORVILLE. Yes.

Senator CASE. Basic research would compare with——

Captain ORVILLE. With the laboratory, and field experimentation, or the operations which are presently being conducted by the commercial cloud seeding, or by the State of California, Santa Barbara County, would be in the nature of field experimentation, or applied research, though there may be some basic facts come from that.

Senator CASE. It is applying the laboratory theory.

Captain ORVILLE. Applying the laboratory theory, and possibly improving our engineering methods of cloud seeding.

Senator CASE. And this bill seeks to take the basic research and get some application in the field?

Captain ORVILLE. That is correct, Senator Case.

Senator CASE. It seeks to take the principles discovered in this basic research as you have evaluated them and applied them to a pilot plant operation, so to speak?

Captain ORVILLE. Yes, sir. The Congress has already established the Advisory Committee on Weather Control, whose membership includes not only representatives from all of these interested Federal agencies but also representatives from the fields of science, agriculture, and business from private life.

The cooperative experimental and research program contemplated by S. 86 involves the interests of many Federal, State, and local public agencies and private organizations and individuals; the coordination of various State, local, and national laboratory and field activities; and direct Federal operations.

The Advisory Committee on Weather Control does not now have the legislative authority to engage in a program of research and experimentation. On the other hand, the Advisory Committee is the only agency currently authorized and, in fact, carrying out studies and evaluations of weather modification experiments, supervised by competent scientist-administrators, which are essential components of such a program.

Now, there follows my suggested amendments, and these are my personal views.

In my opinion, if the Advisory Committee is directed to carry out this program, it is believed that the enactment of certain amendments, given below, would aid in the accomplishment of the proposed legislative objectives.

It would be desirable that funds appropriated annually for the research and experimentation program be authorized to remain available until expended, in some cases possibly for the full period of 5 years.

This comment is contained in reports received from a number of scientists who have communicated their views to the Advisory Committee. They emphasize the need for flexibility in research and the desirability of not restricting annual appropriations to the year in which they are appropriated.

A preliminary survey has indicated that such a provision would not be setting a precedent. It is my view that the funds which would be appropriated, if Senate bill S. 86 is enacted into law, would be solely for carrying out the long-range research program.

Funds for directing the Federal portion of the program, administrative and technical services, would come from the present authorization for conducting the study and evaluation by the Advisory Committee on Weather Control.

The Advisory Committee, as now modestly constituted, is spending approximately $125,000 per annum for administration, personnel, and expert consultants to support and aid in the execution of its actual evaluation activities which are costing an estimated $125,000 per year.

Senator BIBLE. Your point there is in relation to the $5 million program—there would be an additional amount of about $625,000 contemplated over the 5-year period; is that what you are saying?

Captain ORVILLE. What I am saying, sir, is that in order to administer the research program it would require additional funds over and above that which we have at the present time, sir.

Senator BIBLE. So the long-range research program as contemplated would cost approximately $5 million for 5 years?

Captain ORVILLE. $5 million in 5 years' time, sir.

Senator BIBLE. And the administrative expenses of the Advisory Committee on Weather Control would approximately amount to $125,000 each year; is that a correct statement?

Captain ORVILLE. Probably more than that; with the additional research program, I am sure it would cost more than our present expenditures.

Our current annual appropriations and expenditures in the neighborhood of $250,000 have supported a program which is less than one-third as large as the annual program and appropriations contemplated by this bill.

Therefore, we desire to underline our understanding that S. 86 is in addition to the present authority of the Advisory Committee and constitutes authority for the appropriation of funds for the program of research and experimentation contemplated by the bill in addition to the continuation of the authority for obtaining funds for the evaluation program.

Senator BIBLE. Then, taking a 5-year look at this, you are saying the research part of it would cost $5 million, the administrative part would cost $250,000 a year, or $1,250,000, over 5 years, in addition to the $5 million, an additional cost of $250,000 each year.

Captain ORVILLE. That is correct, sir.

May I repeat again that the long-range research program in cloud modification and the present study and evaluation such as that now being carried out by the Advisory Committee on Weather Control must go hand in hand and be carried out by the same Federal agency if this research program is to produce maximum results from the State and Federal funds expended.

In closing I would like to draw the committee's attention to the fact that in January of this year the President personally inspected conditions in the drought-stricken States. As a result of this inspection trip and a simultaneous conference of local interests and State and Federal agencies on drought and other natural disasters, in Wichita, Kans., the President sent a special message to the Congress on March 5. Among many other recommendations of the Wichita conference emphasized by the President in his message is research relating to weather.

S. 86, if enacted, would authorize a Federal-State cooperative research program in weather modification.

I had the pleasure of being one of the participants in the conference at Wichita and can testify as to the importance of this long-range research program if the effects of the next drought period, not the present one, are to be alleviated.

S. 86, with suggested amendments, appears to incorporate all of these desirable features.

APPENDIX

List of references and technical reports:

1. Letter report to President Eisenhower, June 10, 1954.

2. Present Status of Weather Modification, by Howard T. Orville, paper presented before the Section of Oceanography and Meteorology of New York Academy of Sciences, October 26, 1954.

3. Weather Modification Operations in California, Bulletin No. 16, by State Water Resources Board, June 1955.

4. First Report on Operation Overseed, by Robert B. Smith and Roland J. Boucher, covering period August–November 1955.

5. First interim report, by Advisory Committee on Weather Control, submitted to President Eisenhower on February 8, 1956.

6. An Evaluation of a Series of Orographic Cloud Seeding Operations, by H. C. S. Thom, at Second International Symposium on Weather Modification held at Tucson, Ariz., April 10–13, 1956.

7. Evaluation of Weather Modification Experiments, by Frederic A. Berry, presented May 8, 1956, before American Water Works Association.

8. Operational Survey for Weather Modification in an Experimental Area in the TVA Basin, by W. E. Howell Associates, Inc. and others, June 1956.

9. Final Report on Operation Overseed, by Roland J. Boucher, submitted to the Advisory Committee on Weather Control in December 1956.

10. Physical Evaluation of Cloud Seeding Effects, by Dr. Paul B. MacCready, Jr. and others of Meteorology Research, Inc., submitted to the Advisory Committee on Weather Control in December 1956.

11. Preliminary Report on Project Skyfire Operations in the Northern Rockies, by Forest Service, United States Department of Commerce, December 1956.

12. What the Farmer Should Know About Weather Modification (Cloud Seeding), by Howard T. Orville, paper presented at convention of American Farm Bureau Federation, December 10, 1956.

13. Facts and Fiction on Weather Modification (Cloud Seeding), by Howard T. Orville, presented at meeting of New York State Horticultural Society in Kingston, N. Y., on February 1, 1957.

Senator BIBLE. Thank you, Captain Orville.

What has been your experience in finding areas of close cooperation with the Federal agencies involved, the State agencies, or private groups in working out a joint project?

Captain ORVILLE. We have had cordial relations with State groups. We have on a number of occasions attended meetings. We attended one in South Dakota on July 18, at which Governor Foss called a meeting, and we acquainted them with the findings of the committee.

And then subsequently, we met with the Water Resources Committee down in Texas.

And the most recent trip was out to St. Joseph, Mo., where we met with a number of farmers and university people and utility people, and public and civic officials, and acquainted them with the problem. And also told them of the capabilities and limitations—in other words, the fact that we have not solved all the problems by any means.

Senator BIBLE. What firm conclusions do you have at this stage as a result of your operations since 1954—about 3 years?

Captain ORVILLE. We have definitely established in one area, the West Coast States; you can realize an increase in precipitation of about 15 percent. That is a large increase.

There are 24 States that have mountainous areas where the conditions, under favorable weather conditions, might produce increases, too. We are studying the other interior mountain States and studying the flat lands, but we have not come out with any firm result yet, and that is the reason I said in my statement that it appears that statistics may fall down when it comes to proving the results in flat lands, and that we may have to resort to radar, additional rain gage networks, and other observations to determine the results we are getting from the cloud seeding operations in those States.

Senator BIBLE. Have you reached any conclusions from the operations you have conducted in my State of Nevada?

Captain ORVILLE. We have not, sir.

Senator BIBLE. I believe you have had 7 operations there, but whether successful or not, I don't know.

Captain ORVILLE. We have not arrived at any final conclusions. That is because of many difficulties. One is inadequate rain gage network with records of sufficient length of time to give you basic data to start with, and the fact that the operations were not conducted continuously for a long enough period, and there are a great many difficulties that the committee has met up with in attempting to make a formal statistical evaluation of the operations.

Senator BIBLE. How many States have agencies set up to do research and experimental work in this field of cloud seeding, or are authorized to participate with Federal agencies? I am familiar with the statement of Dean Eberle concerning the State of South Dakota. I know my own State of Nevada has 1955 legislation which permits cooperation by designating the State agency to cooperate with Federal agencies. Are there other States?

Captain ORVILLE. There are, but may I call upon Mr. Oppenheimer, our executive secretary.

Mr. OPPENHEIMER. I have here a brief summary of the State laws and activities which I think would be a direct response to your question. If I might read it, it might be useful to the record at this point.

Senator BIBLE. Yes; if it is not too long.

Mr. OPPENHEIMER. Until enactment in August 1953, of the Federal law which established the Advisory Committee on Weather Control for purposes of evaluating weather modification activities, only a few States had passed laws in the field of weather modification or control. However, interest was sufficiently widespread to prompt the Council of State Governments to introduce a model act in its program of suggested legislation for 1953.

By the end of 1954, 10 States, namely, Arizona, California, Colorado, Massachusetts, Nevada, Oregon, South Dakota, Utah, Wisconsin, and Wyoming had provided for regulation of weather modification activities in some degree. Three other States, namely, New Hampshire, New Mexico, and Oklahoma have taken notice of State interests in the field by collateral legislative action.

Only as recently as July 10 of this year, Louisiana became the 14th such State. Most of the State legislatures are having legislative sessions in 1957, at which some of them might consider weather modification legislation. I might say, parenthetically, Mr. Chairman, that apparently, according to Senator Carlson's testimony this morning, the State of Kansas is already considering legislation, and if it enacts such legislation, will become the 15th such State.

Four States, Colorado, Louisiana, South Dakota, and Wyoming, explicitly claim sovereign rights to the moisture in the clouds and atmosphere within their State boundaries. Four of the total of 14 States; namely, California, Massachusetts, New Hampshire, and Wyoming, provide for research and experimentation by State authorities.

Nevada, in 1955, specifically repealed its 1953 regulatory act, and authorized the State and the counties to conduct actual weather modification operations and issue regulations.

Eleven States regulate weather modification activities; 8 of these 11 States require licensing. Most of the 11 States require that prior notice of operations be given to State authorities and/or the general public in the area to be affected. Five States appear to regulate the methods or conditions of operation. Arizona regulates the manufacture, sale, lease, and advertisement of weather modification equipment.

Reports by the operators and evaluation by the State authorities are provided for in a number of regulatory States. All of the States require certain technical qualifications in order to be granted a license to operate.

Financial ability, through insurance or otherwise, to respond in damages for harm done, is expressly or impliedly required in most

of the regulatory States. In a majority of the regulatory States, fees for annual licenses range from $25 to $100. License revocation, fines ranging from $250 to $1,000, and imprisonment for not more than 1 year, are the usual penalties for noncompliance with the State laws and regulations.

Of the 14 States which have regulatory and other laws in the field of weather modification, 4 States, namely, California, Massachusetts, New Hampshire, and Wyoming provide legislative authority for research and experimentation by State agencies or universities. There are existing or emerging State-sponsored research programs in Arizona, California, Florida, Oregon, South Dakota, Texas, and Utah.

I will supply for the record information on the status of State weather modification legislation subsequent to the first day's hearings on S. 86.

(The information referred to follows:)

APRIL 18, 1957.

Mr. HARRY HUSE,
Senate Interstate and Foreign Commerce Committee,
United States Senate.

DEAR MR. HUSE: In accordance with your telephone request of today, there follows the information we have obtained on the status of State weather modification legislation subsequent to the first day's hearings on S. 86.

1. Florida: Legislative proposals pending.
2. Iowa: Proposed legislation in committee.
3. Kansas: Bill passed lower house of legislation.
4. Missouri: Bills being considered in committee.
5. Nebraska: Bills being considered in committee.
6. South Carolina: Bills being considered in committee.
7. Washington: Passed by legislature and just recently enacted into law by approval of the Governor.

Sincerely yours,

JACK C. OPPENHEIMER,
Executive Secretary.

Senator BIBLE. Thank you very much. I think that is a useful contribution for the record.

Did I understand in one of your recommendations, in commenting on Senate bill 86, that you felt it would be better if it was carried on purely as a Federal project, rather than by cooperation?

Captain ORVILLE. No; that was my impression of some of the letters we received from the Federal members.

Senator BIBLE. That is what Dr. Houghton said—did he make that observation?

Captain ORVILLE. No; I said in my statement that was my personal observation in commenting upon letters received from the Federal members.

Senator BIBLE. I wonder what leads to that type of observation? I notice apparently four States are set up to cooperate with the Federal Committee.

Captain ORVILLE. I imagine it is the feeling of those members that the field of weather modification is still in the basic research stage, and is not ready for an extensive field experimentation program—that would be my personal interpretation of those comments.

Senator BIBLE. Of course, this bill does actually move the weather control or cloud modification beyond the basic research, as I understand it, into an actual research program in the field.

Captain ORVILLE. That is true, sir, and I attempted in my statement to point out that we have definitely passed the basic research stage, that we have evidence—Senator Case showed you pictures of the clearing of clouds and the effect of seeding on cumulus clouds, so that we definitely have a toehold in this cloud physics field, and in cloud seeding.

Senator BIBLE. Did you care to clarify the statements that have been made?

Captain BERRY. No, sir.

Senator BIBLE. Senator Case?

Senator CASE. I think Captain Orville has made an excellent statement.

I have a statement here from Jack Barrows, connected with the Forest Service at Missoula, Mont. I happened to meet him recently, and I asked him to give me some information with respect to their experience in seeking to reduce lightning fires in the national forests.

I also have a statement from Mr. Paul MacReady, of Research Associates, of Pasadena, Calif., which is concerned primarily with the removal of supercooled fog by cloud seeding.

Now, most of your statement has been dealing with increased precipitation, Captain Orville. Does the Committee also concern itself with the experimentation in clearing fogbound airfields, or fog conditions generally, and has it also given any attention to the possible suppression of hail or lightning strikes?

Captain ORVILLE. Yes, our staff has recently been in communication with Mr. Henry Harrison, the Superintendent of Meteorology of United Air Lines, and we are at the present time making certain preliminary studies on a selected number of stations throughout the United States to find out how frequently they have supercooled fog at these airports, and this may lead to research and possible clearing of these airports.

Captain Berry, our chief scientific adviser, has had correspondence with Mr. Harrison, and can give further information on that, Mr. Chairman.

Senator BIBLE. We will be glad to hear from Captain Berry.

Captain BERRY. We selected a number of major airports in the Western States where it seemed this might happen often enough so that it would be economically worth while to try to eliminate it—Salt Lake City, Seattle, Portland, and Spokane, Wash. These are all airports with quite a considerable amount of traffic, and also areas where you might expect that this would happen with a certain amount of frequency, so currently the national weather record center at Asheville is running through the punchcard data on these four airports to give us an indication of how many hours of this they experience on the average, every winter.

If it appears to be considerable, then we would hope that we might devise some method of clearing it.

Senator BIBLE. Thank you, Captain.

Senator Case?

Senator CASE. Mr. Chairman, Mr. MacCready in his memorandum which he prepared has this paragraph:

During November 1956, Missoula, Mont., was covered for 10 days and nights by a supercooled low level fog cloud, completely stopping commercial airline

service in Missoula and interrupting much of the airline service in the whole Northwest. On one of those days in Montana Mr. Wells, of the President's Advisory Committee on Weather Control, and I raised dry ice into the cloud by means of a small tethered ballon. The dry ice caused a light snowfall at exactly the spot and time which theory predicted. In addition, the removal of moisture caused a slight hole or clearing in the otherwise solid overcast. These small effects were of value because they agreed with theory and they again verified that cloud seeding can remove supercooled fog or thin supercooled stratus clouds. The test also demonstrated that the seeding could be done from the ground, inexpensively.

Captain Berry, have you discussed this with Mr. Wells?

Captain Berry. No, sir; not with Mr. Wells, but I did discuss it with Dr. MacCready.

Senator Case. You are familiar with this experiment?

Captain Berry. Yes, sir.

Senator Case. And was it attended by the results indicated?

Captain Berry. Yes, sir; it was.

Senator Case. Is Mr. Wells a member of your staff?

Captain Berry. Yes, sir; he is a chief petty officer in the Navy, and is on loan to the staff as a meteorologist.

Senator Case. And Mr. Wells has acted as a consultant or adviser on some of these experimentations with other agencies?

Captain Berry. He actually has more experience in the field, weather modification in the field aspects, than anyone. When the project Cirrus first started at the General Electric Co. at Schenectady, he was on duty up there.

Senator Case. What was that?

Captain Berry. That was a cloud physics project undertaken by the Army, the Navy, with assistance from the Air Force, and it was conducted by the General Electric Research Laboratories.

Senator Case. I would like to ask both you and Captain Orville, under the language of S. 86, would it be possible to engage in experimental research in this matter of clearing fog clouds for fogbound airfields—is our language broad enough for that?

Captain Orville. I believe it is.

Senator Case. I mention that, Mr. Chairman, because that widens the field of interest for this matter of cloud modification. You will recall that at the time of the inaugural here there was considerable question here in Washington as to whether many visitors would get into Washington, or get out during that week when we had a lot of fogbound conditions for the Washington airport.

Senator Bible. Yes, sir.

Senator Case. If this program, if it is brought out that this program has the possibility of field research in that field, it seems to me it widens the interest, and possibly even for Boston, Mass., notwithstanding Dr. Houghton's letter.

Senator Bible. It seems to me that point is well taken. The only limiting language might appear on lines 6, 7, and 8 of the first page which places special reference on areas that have suffered from shortage of natural rainfall.

Senator Case. Obviously that reflected my personal interest in the matter.

Senator Bible. I think it is wise to broaden it certainly, and in line with what has been said here.

Captain Orville. Mr. Chairman, we have assumed that the bill covered the wide field of weather modification, which includes a look

at the smog situation in Los Angeles, which is a weather situation created by man, and is in the form of weather modification. However, our primary interest has been in increasing precipitation, hail and lightning suppression, because those are the most important phases of the program, and would be of greatest economic benefit to the Nation.

Senator CASE. Mr. Chairman, might I suggest that if the committee favorably reports the bill that the staff check on that point and see that perhaps language in the report on the bill could clarify the intent, and that any other suggested technical amendments to the bill be received from the Advisory Committee, or others, for consideration by this committee.

(The information is as follows:)

ADVISORY COMMITTEE ON WEATHER CONTROL,
Washington, 25, D. C., May 20, 1957.

MR. JACK GERKEN,
Office of Senator Francis Case,
United States Senate, Washington 25, D. C.

DEAR JACK: In accordance with our telephone conversation today, there is enclosed a copy of the recommended technical amendments which was part of the original proposed report of the Advisory Committee on S. 86. This portion of the proposed report was eliminated by the Bureau of the Budget at the time it approved a report to be presented before the Senate Interstate and Foreign Commerce Committee.

Nevertherless, pages 5, 52, 93–95, and 107–109 of the hearing transcript of March 26, appear to introduce into the record some if not all of these recommended technical amendments for consideration by the committee in reporting on S. 86. At page 5, Senator Case not only suggests an amendment concerning authority to accept contributions but opens the door to comprehensive amendment of the bill by suggesting that the committee may wish to extend the life of the Advisory Committee. At page 52, Senator Case's question directed to Dean Eberle introduces the notion that there should be an amendment to S. 86 authorizing the Advisory Committee or other administering agency to properly coordinate and control experimental activities and operations by exercising the power to protect the physical integrity of the field experiments from the operations of commercial or other weather modification activities in the same geographical area. At pages 93 to 95, Captain Orville states that it would be desirable that funds appropriated annually for the research and experimentation program be authorized to remain available until expended because of the need for flexibility in research and the desirability of not restricting annual appropriations to the year in which they are appropriated. And, at pages 107 to 109, Senators Case and Bible discuss with Captains Orville and Berry the desirability of clarifying S. 86 to include research in fog dispersal. At page 4, Senator Case himself, suggests amendment 1 of our techncial amendments which for the purpose of clarity would strike the word "either" from line 10 on page 1 of the bill.

I believe that the committee should consider the enclosed suggested technical amendments together with the ones mentioned above in view not only of their desirability but perhaps, more importantly, because of the opportunity created by the record to include some if not all of these amendments in the bill.

Sincerely yours,

JACK C. OPPENHEIMER,
Executive Secretary.

RECOMMENDED TECHNICAL AMENDMENTS

1. The word "either" section 2, line 10, page 1, should be deleted. This change will clarify the method by which contracts shall be carried out.

2. It would be most desirable to have specific authority to negotiate noncompetitive contracts or agreements without regard to existing law as is provided in section 5 of the Department of Health, Education, and Welfare's Air Pollution Control Research Act (69 Stat. 322) and in section 2 (d) of the Interior Department's Saline Water Act (69 Stat. 198; 42 U. S. C. secs. 1951 ff.). The Advisory Committee on Weather Control has found it had to use exceptions

(3) and (4) of the advertising requirements of Revised Statute 3709 (41 U. S. C. sec. 5) to negotiate contracts and agreements with available and qualified technical and professional persons and organizations for the study and evaluation of weather modification activities.

3. Provision should be made that all moneys paid to or received by the Advisory Committee or the United States on behalf of the Advisory Committee under the proposed act shall be credited to the Advisory Committee's appropriations for expenditure in the same manner as its appropriations in order to make clear that State cooperative funds transferred to United States Treasury accounts shall be available for expenditure for the bill's experimentation, research, and development programs.

4. It would be desirable also that sums annually appropriated for the research and experimentation program be authorized to remain available until expended. Such a provision is found in section 5 (a) of the above cited Air Pollution Control Research Act. Several of the State agencies, State universities, and scientists have communicated with the Advisory Committee as to the scientific importance of retaining flexibility by not restricting the expenditure of annual appropriations to the year in which they are appropriated.

5. Consistent with other statutes establishing research and development programs, authority should be given the Advisory Committee to issue rules and regulations to effectuate the puropses of the proposed act.

6. Section 10 (a) of Public Law 664 84th Congress (70 Stat. 509) approved July 9, 1956, the act entitled "An act to create a Committee to Study and Evaluate Public and Private Experiments in Weather Modification" should be amended to read "June 30, 1962." The reason for this amendment is to extend the life of the Advisory Committee to correspond with the expiration date of the 5-year program authorized by S. 86.

Senator BIBLE. I think the intent could be clarified by proper language in the report.

Captain ORVILLE. Mr. Chairman, I have three more letters, all of which are short, which I would like to introduce in the record. One is from Dr. Werner A. Baum, head of the department of meteorology of Florida State University.

Senator BIBLE. The letter may be included in the record.

(The letter is as follows:)

THE FLORIDA STATE UNIVERSITY,
Tallahassee, Fla., January 26, 1957.

Capt. H. T. ORVILLE, USN (Retired),
Advisory Committee on Weather Control, Washington, D. C.

DEAR CAPTAIN ORVILLE: I was delighted to receive your letter of January 24 and the copy of Senate bill S. 86. This bill incorporates many desirable features and should lead, at last, to the kind of investigation needed to resolve many of the doubts in the minds of both the public and the meterological profession.

I am particularly happy to note (1) provision for a long-range program, (2) cooperative programs between the individual States and the Federal Government, and (3) the lack of detailed specifications, which will permit maximum freedom of adjustment to our ever-changing scientific knowledge.

One point does give me some concern. I hope that the wording of section 3, particularly line 7, does not imply that all appropriations which may be made to implement this bill will be 1-year appropriations. It is not possible to conduct large-scale research efforts, particularly when they involve field operations, effectively under a fiscal arrangement which provides that new funds be tapped each July 1, unspent old funds reverting to the Treasury. The progress of scientific experiments is exceedingly difficult to anticipate, and the need for funds is not even remotely uniform over the lifetime of the experiment. One-year appropriations result in fund excesses at some times, which often result in expenditures on trimmings rather than in a return to the Treasury, and in fund shortages at other times. One-year funding is, in my judgment, one of the basic difficulties in the operation of the national hurricane research project, for example.

I have already called the existence and implications of the bill to the attention of Governor Collins. While I cannot speak officially for the State of Florida at this time, I feel confident that our State will take an active interest in the opportunities this program would provide.

We cannot provide any detailed outline, even though it be tentative of an experimental research program by your stated deadline of February 10. However, from our general climatic conditions it is clear that we have a particularly strong interest in pursuing the problems of inducement of precipitation from "warm" clouds and of the dissipation of violent cumulonimbus clouds which threaten to do damage.

If the State of Florida, or I personally, can be of any assistance in connection with this bill, please do not hesitate to let me know. In any case, we hope you will keep us informed of developments in the matter.

Sincerely yours,

WERNER A. BAUM,
Head, Department of Meteorology.

Senator BIBLE. Is his letter in favor of the bill, S. 86?

Captain ORVILLE. Yes, sir.

The other letter is from Dr. Horace R. Byers, chairman of the Department of Meteorology of the University of Chicago.

Senator BIBLE. Likewise favoring S. 86?

Captain ORVILLE. Yes, and including basic studies which might be conducted by the committee.

Senator BIBLE. The letter may be included.

(The letter is as follows:)

THE UNIVERSITY OF CHICAGO,
DEPARTMENT OF METEOROLOGY,
Chicago, Ill., February 7, 1957.

Capt. H. T. ORVILLE,
Chairman, Advisory Committee on Weather Control,
Washington, D. C.

DEAR CAPTAIN ORVILLE: Thank you for your letter of January 24 and your invitation to us to submit ideas and proposals in connection with the activities provided for in Senate bill S. 86.

We have not explored the extent of interest in the State of Illinois in matching funds to be appropriated under this proposed legislation, but believe that Illinois would be in a position to operate in this manner through the meteorologic subdivision (under Mr. Glenn E. Stout) of the water survey division. The University of Chicago would be eligible to participate under the contract provisions of section 3 of the bill.

We have plans to augment our research both in the fundamental and applied aspects of cloud physics and weather modification, concentrating on problems which are most obviously in need of solution. We find that the support for this work is inadequate, largely because of changes in Department of Defense requirements which formed the basis of our work in the past few years. Hence we welcome more active participation by other public agencies.

The areas of the science in which we feel strong emphasis should be placed and in which we are equipped to perform the research are the following:

I. BASIC STUDIES

(*a*) Data on clouds and cloud processes in relation to weather systems—field studies from the ground and in the air.

(*b*) Fundamental studies of the physics and chemistry of precipitation mechanisms, including cloud-charging processes—laboratory and airplane measurements.

(*c*) Fundamental studies of chemistry of seeding agents—laboratory and field.

II. APPLIED RESEARCH

Cloud modification studies involving—

(*a*) Airborne AgI seeding
(*b*) Airborne measurements in clouds
(*c*) Radar studies (ground and airborne)
(*d*) Microphysical measurements of nucleating action in clouds.

We have assurance that the assignment of an Air Force aircraft to our project is expected to continue. It is believed that the availability of a fully equipped

cloud physics research aircraft would be important for many aspects of your investigations.

Sincerely yours,

HORACE R. BYERS,
Chairman, Department of Meteorology.

Captain ORVILLE. The third is from Richard J. Roth, assistant manager of the Crop-Hail Insurance Actuarial Association of Chicago. This brings out the interest of this organization in hail suppression, and that, of course, will be of interest.

Senator BIBLE. That letter likewise will be included in the record.

(The letter is as follows:)

CROP-HAIL INSURANCE ACTUARIAL ASSOCIATION,
Chicago, Ill., February 19,1957.

ADVISORY COMMITTEE ON WEATHER CONTROL,
General Services Administration Building,
Washington 25, D. C.

GENTLEMEN: We are pleased to note the proposed legislation which would provide for an experimental research program in cloud modification.

Specifically, of course, we are interested in seeing hail suppression experiments started with consequent evaluation of possible effectiveness. This would have to be accompanied with a much more complete understanding of the mechanism of hail formation and fall.

The thunderstorm project provided much valuable data, but, unfortunately, was carried out in areas of low hail frequency. Consequently, little is known about hail, and its study remains practically an unexplored field.

There is, of course, great hail damage each year to crops, buildings, automobiles, and other property. This association has considerable information from all parts of the United States about hail losses to crops derived from our insurance experience. Perhaps this may be of some use if the proposed research is approved by Congress.

We wish to recommend that experiments in hail suppression be carried out in areas of high hail frequency such as western Kansas, western Nebraska, or eastern Colorado. In order to accomplish this, research in cloud physics as related to hail formation and fall would be essential.

Very truly yours,

RICHARD J. ROTH,
Assistant Secretary and Manager.

Senator BIBLE. Thank you very much for your testimony, Captain Orville, Captain Berry, and Mr. Openheimer.

I would like to have included at an appropriate place in the record a statement from Congressman Berry of South Dakota on this legislation.

(The statement of Representative Berry is as follows:)

STATEMENT OF REPRESENTATIVE E. Y. BERRY ON S. 86, SENATE INTERSTATE AND FOREIGN COMMERCE COMMITTEE

Mr. Chairman and members of the committee, I appreciate this opportunity to appear before you and testify in support of S. 86, a bill to provide for an experimental research program in cloud modification. I have introduced an identical bill, H. R. 5232, in the House.

Since the time man was created water has been the most valuable commodity to the human race. As populations increased it became necessary for man to grow crops to provide food rather than depend on the provisions of nature. Since that time, the existence of prosperity or famine have been largely dependent on rainfall and wise use of available water.

Mark Twain once said, "Everyone talks about the weather, but no one does anything about it." This is no longer true as cloud seeding to increase rainfall has become a miracle of our fantastic age. There is no question but what the method of seeding silver iodide particles in clouds has produced rain, but we must now determine the extent to which this discovery can be used to benefit mankind and the degree of accuracy that can be attained in bringing down the

lifegiving moisture from the heavens. The purpose of this bill is to allow for a thorough study of the accomplishments as well as the potential of cloud modification.

The bill authorizes an appropriation of $5 million for a 5-year program to formulate a program of experimental research in cloud modification with special reference to areas that have suffered from shortage of natural rainfall. The program is to be carried on either by contracts between the Advisory Committee on Weather Control and private or public agencies and through cooperative programs with State agencies, including land-grant colleges or other State agencies to be developed by the Governor of the State.

Of the $5 million, one-fourth shall be available for that part of the program to be accomplished by contract and three-fourths shall be available for the cooperative program to be matched equally by the States. I am informed that some States already have funds available to match these Federal funds. They are California, Texas, Florida, and South Dakota. Other States have indicated legislative action appropriating the needed matching funds would be forthcoming and, in the meantime, work would go ahead on the Federal Government contract basis with the $1¼ million that would be utilized in this category.

The bill specifies the study program will be concentrated on areas which have suffered from shortages of natural rainfall. This is logical because conclusive results have been reached in the western mountainous areas, but there is still some question whether silver iodide can be carried into the plains area which experts advise me "require supercooled clouds."

This legislation is badly needed at the present time because the Advisory Committee on Weather Modification currently has authority for evaluation only. This bill would provide for actual study by the Committee through contracts with private and public groups. It would amount to an independent experiment by a public agency to determine the effectiveness and potentiality of cloud modification, rain increasing, or whatever you choose to call it.

I wish to emphasize that the Advisory Committee should be directed by this congressional committee to make full and complete use of the knowledge and background experience compiled by the private companies and State weather modification commissions which have worked with nonprofit associations of farmers and ranchers in developing cloud modification over the past 8 years. It is essential that these three groups receive proper recognition for their pioneering achievements. The only way this can be done is through proper utilization of the methods and machines they have devised over the years.

The land-grant colleges are ready and willing to help in these studies but the men, machines, and methods of the private companies, nonprofit farmers' and ranchers' organizations, and the State weather modification commissions, must be integrated into the plan of research and study.

Capt. Howard T. Orville, Chairman of the Presidential Advisory Committee on Weather Control, spoke recently before the New York Horticulture Society at which time he summarized the evidence that cloud seeding for rain increasing and hail suppression does work. He lists the results of the Committee's evaluation program as follows:

1. That supercooled stratified clouds can be dissipated by aircraft seeding with dry ice or silver iodide.

2. That precipitation can be initiated by seeding warm cumulus clouds with water.

3. That dry ice and silver iodide seeding of cumulus clouds extending to 5,000 feet or more above the freezing line and with a temperature at the top of the cloud of —10° Centigrade will induce precipitation.

4. That ground generator seeding with silver iodide in the 3 Pacific Coast States has produced average increases of 9 to 17 percent under the conditions mentioned in an earlier paragraph.

5. That an intensive study of hail prevention and the possibility of reducing lightning seems well justified. Many destructive forest fires in the Western States are started by lightning strikes. It is believed that cloud seeding will start the precipitation process earlier and will prevent the storms from building up to hail and lightning-producing proportions. Much more study of this problem must be made before any final conclusions can be drawn.

6. That Federal regulation of rain-increasing operations is not justified at this time.

7. That continued controlled experimentations hold promise of developing new techniques which may be of greatest economic importance to the farmer.

The value of rain increasing is evidenced by the fact that economic studies indicate a 10-percent increase in precipitation would mean 12 million additional bushels to South Dakota wheat growers. Translated into dollars, this would amount to $24 million added income in 1 State if wheat was $2 a bushel. With rain-increasing costs estimated at 5 cents per acre the total cost would only be $200,000.

I am concluding my statement with a listing of the rain-increasing activities in South Datkota since 1950, which is attached hereto and by reference made a part hereof.

Thank you.

REPORT ON CLOUDSEEDING ACTIVITIES IN SOUTH DAKOTA FROM 1950 TO 1957

FISCAL YEAR JULY 1950–JUNE 1951

Western South Dakota Rain Increasing Corp., client, and the Water Resources Development Corp., Denver, Colo., contractor. In Meade, Pennington, Custer, and Fall River Counties. From May 15 to September 30, 1951. Conducted to increase rainfall for agricultural and grazing purposes.

Western Central South Dakota Weather Improvement Association, client, and the Water Resources Development Corp., Denver, Colo., contractor. In Faulk, Haskon, Hughes, Hyde, Jackson, Jones, Potter, Stanley, and Sully Counties. From June 15 to September 30, 1951. Conducted to increase rainfall for agricultural and grazing purposes.

Grand River Valley Weather Improvement Association, client, and the Weather Modification Co., contractor. In all of Corson, most of Perkins, and part of Dewey and Ziebach Counties. From May 15, 1951, to July 31, 1952. Conducted to increase rainfall for agricultural and grazing purposes.

FISCAL YEAR JULY 1951–JUNE 1952

Grand River Valley Weather Improvement Association, client, and the Weather Modification Co., contractor. In all of Corson, most of Perkins, and parts of Dewey and Ziebach Counties. From May 15, 1951, to July 31, 1952. Conducted to increase rainfall for agricultural and grazing purposes.

Western South Dakota Rain Increasing Corp., client, and the Water Resources Development Corp., Denver, Colo., contractor. In parts of Meade, Pennington, Custer, and Fall River Counties. From May 15 to September 30, 1951. Conducted to increase the rainfall for agricultural and grazing purposes.

West Central South Dakota Weather Improvement Association, client, and the Water Resources Development Corp., Denver, Colo., contractor. In Faulk, Haskon, Hughes, Hyde, Jackson, Jones, Potter, Stanley, and Sully Counties. From June 15 to September 30, 1951. Conducted to increase rainfall for agricultural and grazing purposes.

FISCAL YEAR JULY 1952–JUNE 1953

Western South Dakota Rain Increasing Corp., client, and the Water Resources Development Corp., Denver, Colo., contractor. In parts of Meade, Pennington, Custer, and Fall River Counties. From May 15 to July 31, 1953. Conducted to increase rainfall for agricultural purposes.

West Central South Dakota Weather Improvement Association, client, and the Water Resources Development Corp., Denver, Colo., contractor. In Haskon, Jones, Lyman, and Hughes Counties. From May 15 to July 15, 1953. Conducted to increase rainfall for agricultural and grazing purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In all of Brown and Spivak Counties and part of Edmunds County. From April 7 to June 19, 1953. Conducted to increase rainfall for agricultural and grazing purposes.

Grand River Valley Weather Improvement Association, client, and the Weather Modification Co., contractor. In all of Corson, most of Perkins, and parts of Dewey and Ziebach Counties. From May 15, 1951, to July 31, 1952, and from June 9, to July 31, 1953. Conducted to increase rainfall for agricultural and grazing purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In Hyde, Hand, Beadle, Jerauld, Buffalo, and Aurora Counties. From April 7, to October 31, 1953. Conducted to increase rainfall for agricultural and grazing purposes.

FISCAL YEAR JULY 1953–JUNE 1954

Western South Dakota Rain Increasing., client, and the Water Resources Development Corp., Denver, Colo, contractor. In parts of Meade, Pennington, and Custer Counties. From April 28 to July 13, 1954, and from August 7 to 28, 1953. Conducted to increase rainfall for agricultural and grazing purposes.

West Central South Dakota Weather Improvement Association, client, and the Water Resources Development Corp., Denver, Colo., contractor. In all of Stanley and Hughes Counties and parts of Jones, Lyman, and Sully Counties. From May 25 to July 25, 1954. Conducted to increase rainfall for agricultural and grazing purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In parts of Spival, Edmunds, Brown, and Marshall Counties. From May 14 to July 31, 1954. Conducted to increased rainfall for agricultural and grazing purposes.

The Water Resources Development Corp., Denver, contractor. In all of Aurora, Buffalo, and Jerauld Counties, and parts of Beadle and Kingsbury Counties. From April 7 to October 31, 1953. Conducted to increase rainfall for agricultural and grazing purposes.

Grand River Valley Weather Improvement Association, client, and the Weather Modification Co., contractor. In all of Corson, most of Perkins, and parts of Dewey and Ziebach Counties. From June 1 to July 31, 1953. Conducted to increase rainfall for agricultural and grazing purposes.

FISCAL YEAR JULY 1954–JUNE 1955

Western South Dakota Rain Increasing Corp., client, and the Water Resources Development Corp., Denver, Colo., contractor. In parts of Meade, Pennington, and Custer Counties. From August 7 to 21, 1954, and from April 28 to July 13, 1954. Conducted to increase rainfall for agricultural and grazing purposes.

West Central South Dakota Weather Improvement Association, client, and the Water Resources Development Corp., Denver, Colo, contractor. In all of Stanley and Hughes Counties and parts of Sully, Jones, and Lyman Counties. From May 25 to July 25, 1954. Conducted to increase rainfall for agricultural and grazing purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In parts of Marshall, Brown, Edmunds, and Spivak Counties. From May 14 to July 31, 1954. Conducted to increase rainfall for agricultural and grazing purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In all of Aurora, Buffalo, and Jerauld Counties, and parts of Beadle and Kingsbury Counties. From May 14, 1954, to August 5, 1954. Conducted to increase rainfall for agricultural and grazing purposes.

FISCAL YEAR JULY 1954–JUNE 1955

The Water Resources Development Corp., Denver, Colo., contractor. In Custer County. From August 26, 1954, to September 30, 1954. Conducted to increase rainfall for agricultural and grazing purposes.

FISCAL YEAR JULY 1955–JUNE 1956

No recorded activity.

FISCAL YEAR JULY 1956–JUNE 1957

Sioux Valley Weather Association, Inc., Alcester, client, and the Water Resources Development Corp., Denver, Colo., contractor. In all of Lincoln, Union, and Clay Counties; all of Yankton County except the 2 northwest townships; 5 southeast townships in Turner County, and all but 1 northwest township in Bon Homme County. From July 1, 1956, to June 30, 1957. Conducted to increase rainfall for agricultural and grazing purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In Gregory County. From September 12, 1956, to September 12, 1957. Conducted to increase precipitation for agricultural and grazing purposes.

Senator BIBLE. Are there any other appearances this morning?

I have a listing of Mr. Krick. Is Mr. Krick here?

He will have ample opportunity to appear. Would he be available this afternoon?

The chairman has no objection, for the purpose of permitting Mr. Krick to be heard—he is here from Denver, Col., and we certainly will want to accommodate him. I suggest that the subcommittee reconvene at 2 o'clock, and would he be available at that time?

Captain ORVILLE. Yes, sir; he will be.

Senator CASE. Mr. Chairman, I have two matters here I would like to insert, the statement of Dr. MacCready, and a summary of the importance of research for control of lightning and fires in national forests.

Senator BIBLE. It may be understood that both documents will be incorporated at this point in the record.

(The material referred to is as follows:)

MEMORANDUM CONCERNING THE REMOVAL OF SUPERCOOLED FOG BY CLOUD SEEDING

Cutting holes in flat stratus clouds or fog at below freezing (supercooled) temperatures is a type of cloud seeding which has received complete acceptance from members of the meteorological profession. This acceptance is due to the incontrovertible evidence of success obtained by Dr. Vincent Schaefer and others in 1947 in Project Cirrus, and more recently duplicated by United States Signal Corps experiments. In these tests dry ice was dropped into the clouds from an airplane. The physical mechanism of this simple type of cloud seeding is fairly well understood, which means it is only an engineering problem to put it to practical use.

During November 1956, Missoula, Mont., was covered for 10 days and nights by a supercooled low-level fog cloud, completely stopping commercial airline service to Missoula and interrupting much of the airline service in the whole Northwest. On one of those days in Montana Mr. Wells, of the President's Advisory Committee on Weather Control, and I raised dry ice into the cloud by means of a small tethered balloon. The dry ice caused a light snowfall at exactly the spot and time which theory predicted. In addition, the removal of moisture caused a slight hole or clearing in the otherwise solid overcast. These small effects were of value because they agreed with theory and they again verified that cloud seeding can remove supercooled fog or thin supercooled stratus clouds. The test also demonstrated that the seeding could be done from the ground, inexpensively.

A variety of techniques would be available in these weather conditions for removing the low supercooled cloud from the airport at Missoula, and even for bringing sunshine to the whole valley. Dry ice could be put aloft on tethered balloons, dropped from airplanes, or set on hills. Silver iodide generators could be carried by an airplane or tethered balloon, set on hills, or the silver iodide smoke could be carried aloft by an air jet, or heat source, or even by the convection current over a river. The method chosen would depend on the topography, meteorological situation, and the economics involved.

The President's Advisory Committee on Weather Control is now performing a study to see how many times a year these supercooled clouds stop air traffic in areas such as Seattle, Portland, and Salt Lake City. If the need is great enough, this type of cloud removal will start being done on a routine, practical basis. Other phases of weather modification such as rain increasing and hail and lightning decreasing show promise, but until further research provides better understanding of the physical mechanisms involved they will not offer the sure results obtainable with supercooled cloud removal.

PAUL B. MACCREADY, JR.,
Research Associate, the Munitalp Foundation, Inc.,
Pasadena, Calif.

STATEMENT ON LIGHTNING FIRE RESEARCH

(Submitted by Senator Francis Case and based on informal interviews with persons in the U. S. Forest Service)

Lightning is the greatest single cause of forest fires in the western United States. Fires starting from lightning storms are the target of a coop-

erative-research program known as Project Skyfire being carried on by the Forest Service in cooperation with several other scientific groups. The purpose of Project Skyfire is to develop more effective means of lightning-fire suppression, including the possibility of preventing lightning fires and reducing fire danger through cloud seeding.

During the 1957 forest-fire season in the West, Project Skyfire is ready to carry out experiments in new techniques for lightning-fire suppression. Ability to go forward with this far-reaching experiment requires an increase in the Forest Service appropriation item for forest-fire-control research. The fiscal year 1958 Forest Service budget contains an increase of $51,400 for this item, part of which will be used to support lightning-fire research.

Examination of the costs and losses from forest fires show why lightning-fire research as being carried out by the Forest Service is so essential for better forest protection. During the last 16 years nearly 100,000 lightning fires occurred on forest lands in 12 Western States. The annual cost of lightning fires varies widely according to fire danger and lightning storm occurrence. The average cost of lightning fires is estimated at about $25 million on 258 million acres of forest lands in the Rocky Mountain and Pacific Coast States.

The following table summarizes lightning fire occurrence in the West:

Lightning fire occurred in Western States, 1940–55

State	Total number of lightning fires 1940–55	Average annual number of lightning fires	Percent of fires [1] in State that are lightning caused
Washington	8,092	506	28
Oregon	15,503	969	52
California	14,981	936	26
Montana	9,720	608	71
Idaho	15,997	1,000	69
Wyoming	1,569	98	62
South Dakota	1,715	107	62
Colorado	2,348	147	35
Arizona	20,029	1,252	84
New Mexico	7,736	483	79
Nevada	464	29	34
Utah	1,309	82	35
Total	99,463	6,216	49

[1] All other fires are man caused.

NOTE.—In the northern Rockies (Idaho, Montana, Wyoming), 69 percent of all forest fires are lightning caused.

In the central and southern Rockies (Colorado, Utah, Nevada, Arizona, New Mexico, and South Dakota) 69 percent of all forest fires are lightning caused.

In the Pacific States (Oregon, Washington, and California) 33 percent of all forest fires are lightning caused

Lightning is a critical factor in forest fire occurrence because a single storm may ignite hundreds of fires in a short period. These fires usually break out in the high mountain country where fire fighting is difficult and potential damage is great to watersheds, timber, and other forest resources. The simultaneous ignition of a large number of forest fires places a great burden on the fire-fighting organizations. Increased forest values and the demands of an expanding population for water, timber, and other products of forests require that better methods be developed for lightning fire suppression.

There are good prospects that the Forest Service fire research program can develop more effective and economical lightning fire control. Project Skyfire is developing special cloud seeding techniques which may possibly result in lightning prevention and reduction of fire danger. Radar and other electronic equipment is being developed for detecting and tracking lightning storms. Special equipment and observation techniques are being developed so that personnel at forest fire lookout stations can provide essential information on clouds and lighting to fire-fighting forces. Atmospheric studies are contributing important facts on lightning storm characteristics and on fire behavior. This information is needed in cloud seeding experiments, but in addition may assist in predicting when and where fires may be expected to burn violently. Research of this type may bring about new fire prevention methods and also lead to safer fire-fighting practices.

The Project Skyfire research group carried out exploratory cloud seeding experiments in the West during the 1956 fire season. The results of this preliminary work are encouraging. There are indications that under proper conditions the growing cumulus-type clouds which are the forerunners of lightning can be modified. Such modification may lead to lightning suppression. Work has been started on the development of special techniques and equipment for field experiments of lightning suppression. A new, high-output seeding generator has been designed and is being readied for field tests. If sufficient forest fire control research funds are available Project Skyfire will carry out its first lightning fire suppression experiments during the 1957 fire season in the northern Rockies.

Excellent scientific assistance is available to the Forest Service fire research personnel engaged in lightning experiments. The Project Skyfire staff includes outstanding scientists from the Munitalp Foundation, the President's Advisory Committee on Weather Control, the United States Weather Bureau, and western universities. Existing facilities on the national forests are being used wherever possible to assist in the project.

Senator BIBLE. The committee will be in recess until 2 o'clock.

(Whereupon, at 12:08 p. m., a recess was taken until 2 p. m. of the same day.)

AFTERNOON SESSION

Senator BIBLE. The hearing will come to order.

At this time, Miss Reporter, I would like to have included in the record a report on the cloud-seeding activities in the State of Texas, from 1950 to 1957; a report on cloud-seeding activities in Nevada from 1950 to 1957; a report on the same subject in Kansas from 1950 to 1957. A report on the same activity in South Dakota from 1950 to 1957, is included in the statement of Congressman E. Y. Berry of South Dakota, on page 51.

(The reports referred to are as follows:)

REPORT ON CLOUD-SEEDING ACTIVITIES IN TEXAS, FROM 1950 TO 1957

FISCAL YEAR JULY 1950 TO JUNE 1951

The Brooks-Jim Hogg Agricultural Development Association, client, and the Water Resources Development Corp., Denver, Colo., contractor. In Jim Hogg and Brooks Counties. From March 8, 1951, to October 31, 1951. Conducted to increase rainfall for agricultural purposes.

The Coastal Bend Agricultural Improvement Association, client, and the Water Resources Development Corp., Denver, Colo., contractor. In Jim Wells, Nueces, and San Patricio Counties. From March 13, 1951, to June 15, 1951. Conducted to increase rainfall for agricultural purposes.

The Border Livestock Association, client, and the Water Resources Development Corp., Denver, Colo., contractor. In Maverick, Dimmit, La Salle and Webb Counties. From March 7, 1951, to June 15, 1951. Conducted to increase rainfall for agricultural and grazing purposes.

FISCAL YEAR JULY 1951 TO JUNE 1952

The Water Resources Development Corp., Denver, Colo., contractor. In the panhandle in Dallam, Hartley, Sherman, Hansford, Ochiltree, and Lipscomb Counties. From May 1952 to April 1953. Conducted to increase rainfall for agricultural purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In Armstrong, Donley, Collingsworth, Hall, Childress, and Cottle Counties. From April 1, 1952, to March 31, 1953. Conducted to increase rainfall for agricultural purposes.

The Brooks-Jim Hogg Agricultural Development Association, client, and the Water Resources Development Corp., Denver, Colo., contractor. In Jim Hogg and Brooks Counties. From March 8, 1951, to October 31, 1951. Conducted to increase rainfall for agricultural purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In Yoakum, Terry, Lynn, Gaines, Dawson, Borden, Andrews, Martin, Howard, Mitchell, Midland, and western Garza Counties. From April 1952 to September 1952. Conducted to increase rainfall for agricultural purposes.

FISCAL YEAR JULY 1952–JUNE 1953

The Water Resources Development Corp., Denver, Colo., contractor. In the panhandle in Dallas, Hartley, Sherman, Hansford, Ochiltree, and Lipscomb Counties. From May 1952 to April 1953. Conducted to increase rainfall for agricultural purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In Armstrong, Donley, Collingsworth, Hall, Childress, and Cottle Counties. From April 1, 1952, to March 31, 1953. Conducted to increase rainfall for agricultural purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In Yoakum, Terry, Lynn, Gaines, Dawson, Borden, Andrews, Martin, Howard, Mitchell, Midland, and wester Garza Counties. From April 1952 to September 1952 and from January 1, 1953, to May 1953. Conducted to increase rainfall for agricultural purposes.

The city of Dallas, client, and the Water Resources Development Corp., Denver, Colo., contractor. In the watershed above the city of Dallas. From November 22, 1952, to May 22, 1953. Conducted to increase rainfall for increase in municipal water supply.

FISCAL YEAR JULY 1953–JUNE 1954

The Water Resources Development Corp., Denver, Colo., contractor. In all of Lipscomb and the northern part of Hemphill Counties. From November 1, 1953, to May 11, 1954. Conducted to increase rainfall for increase in municipal water supply.

The city of Dallas, client, and the Water Resources Development Corp., Denver, Colo., contractor. In the watershed above the city of Dallas. From January 1954 to September 1954. Conducted to increase rainfall for increase in municipal water supply.

The Water Resources Development Corp., Denver, Colo., contractor. Near the town of Sagerton. From January 1954 to July 27, 1954. Conducted to increase rainfall for agricultural purposes.

The Water Resources Development Corp., Denver, Colo., contractor. Near the city of Quanah. From February 1954 to July 27, 1954. Conducted to increase rainfall for agricultural purposes.

FISCAL YEAR JULY 1954–JUNE 1955

The ctiy of Shreveport, client, and the Water Resources Development Corp., Denver, Colo., contractor. In southeastern Marion and northeastern Harrison Counties. From December 1, 1954, to March 31, 1955. Conducted to increase rainfall for increase in municipal water supply.

The city of Dallas, client, and the Water Resources Development Corp., Denver, Colo., contractor. In the watershed above the city of Dallas. From January 1954 to September 1954 and from May 15, 1955, to May 15, 1956. Conducted to increase rainfall for increase in municipal water supply.

The Water Resources Development Corp., Denver, Colo., contractor. Near the town of Sagerton. From January 1954 to July 27, 1954. Conducted to increase rainfall for agricultural purposes.

The Water Resources Development Corp., Denver, Colo., contractor. Near the city of Quanah. From February 1954 to July 27, 1954. Conducted to increase rainfall for agricultural purposes.

The Mill Iron Ranches, Denver, Colo., client and the Water Resources Development Corp., Denver, Colo., contractor. Three target centers in parts of Collingsworth, Hall, Motley and Cottle Counties. From January 1, 1955, to January 1, 1956. Conducted to increase rainfall for agricultural and grazing purposes.

The West Texas Utilities Co., Abilene, client, and the Water Resources Development Corp., Denver, Colo., contractor. In the watershed drainage of the Lytle River near Abilene. From May 1, 1955 to July 1, 1955. Conducted to increase rainfall for increased runoff for hydroelectric power.

The Water Resources Development Corp., Denver, Colo., contractor. In all of Lipscomb and the northern part of Hemphill Counties. From March 1955 to June 1955. Conducted to increase rainfall for increase in municipal water supply.

FISCAL YEAR JULY 1955–JUNE 1956

The city of Fort Worth, client and the Corn Weather Control Foundation, Fort Worth, contractor. In all the watershed areas of Lake Worth, Eagle Mountain Lake, and Lake Bridgeport. From April 1, 1956, to April 13, 1956. Conducted primarily to start rain in cumulus and stratus clouds which extend into the freezing level and boost the rate of fall where rain is occurring. Secondary purpose is hail suppression when warranted.

The city of Shreveport, client and the Water Resources Development Corp., Denver, Colo., contractor. In southeastern Marion and northeastern Harrison Counties. From January 11, 1955, to January 11, 1956. Conducted to increase rainfall for increase in municipal water supply.

The city of Dallas, client, and the Water Resources Development Corp., Denver, Colo., contractor. In the watershed above the city of Dallas. From May 15, 1955, to June 1956. Conducted to increase rainfall for increase in municipal water supply.

The Mill Iron Ranches, Denver, Colo., client, and the Water Resources Development Corp., Denver Colo., contractor. Three target centers in parts of Collingsworth, Hall, Motley, and Cottle Counties. From January 1, 1955, to November, 1955. Conducted to increase rainfall for agricultural and grazing purposes.

The West Texas Utilities Co., Abilene, client, and the Water Resources Development Corp., Denver, Colo., contractor. In the watershed drainage of the Lytle River near Abilene. From May 1, 1955, to June, September 1955. Conducted to increase rainfall for increased runoff for hydroelectric power.

The city of Fort Worth, client, and the Water Resources Development Corp., Denver, Colo., contractor. In the watershed for the city of Fort Worth. From May 1, 1956, to May 1, 1957. Conducted to increase rainfall for increase in municipal water supply.

Advisory Committee on Weather Control, Project Sailplane. At Dallas. On May 14, 1956. An evaluation project for investigation of a silver-iodide plume 2 miles from a ground generator by radar.

FISCAL YEAR JULY 1956–JUNE 1957

The city of Dallas, client, and the Water Resources Development Corp., Denver, Colo., contractor. In the watershed above the city of Dallas. From July 1956 to November 25, 1956. Conducted to increase precipitation for increase in municipal water supply.

The Mill Iron Ranches, Wellington, client, and the Water Resources Development Corp., Denver, Colo., contractor. Three target centers in parts of Collingsworth, Hall, Motley, and Cottle Counties. From May 23, 1956, to July 5, 1956. Conducted to increase precipitation for agricultural and grazing purposes.

The city of Fort Worth, client, and the Water Resources Development Corp., Denver, Colo., contractor. In the watershed for the city of Fort Worth. From May 1, 1956, to November 30, 1956. Conducted to increase precipitation for increase in municipal water supply.

Report on Cloud-Seeding Activities in Nevada, From 1950–57

FISCAL YEAR JULY 1950–JUNE 1951

Water Resources Development Corp., Denver, Colo., contractor. In Elko County. From May 1, 1951, to July 1, 1951. Conducted to increase rainfall for argicultural purposes.

FISCAL YEAR JULY 1951–JUNE 1952

Water Resources Development Corp., Denver, Colo., contractor. In Elko County. From September 5, 1951, to March 15, 1952. Conducted to increase rainfall for agricultural purposes.

FISCAL YEAR JULY 1952–JUNE 1953

No recorded activity.

FISCAL YEAR JULY 1953–JUNE 1954

No recorded activity.

FISCAL YEAR JULY 1954–JUNE 1955

White Pine Cloud Seeding Committee, Ely, client, and Water Resources Development Corp., Denver, Colo., contractor.

In all of White Pine County and parts of Nye and Lincoln Counties. From December 1, 1954, to June 1, 1955. Conducted to increase rainfall for grazing and agricultural purposes.

North Board of Control, Owyhee project, Nyassa, Oreg., and South Board of Control, Owyhee project, Homedale, Idaho, clients, and North American Weather Consultants of Oregon, Altadena, Calif., contractor. In parts of Elko and Humboldt Counties. From January 15, 1955, to May 15, 1955. Conducted to increase precipitation for increased power output.

Salmon River Canal Co., Hollister, Idaho; Oakley Canal Co., Oakley, Idaho; Cedar Mesa Reservoir & Canal Co.; R. J. Harper and J. Spencer Black, of Almo, Idaho, agents for individuals who have contributed to the project, clients and North American Weather Consultants, Altadena, Calif., contractor. In the northeast corner of Elko County. From November 1, 1954, to April 30, 1955. Conducted to increase precipitation for increased power output.

Nevada State Cloud Seeding Committee, Carson City, client, and Water Resources Development Corp., Denver, Colo., contractor. In parts of Humboldt, Pershing, Lander, Elko, and Eureka Counties. From January 1, 1955, to June 1, 1955. Conducted to increase rainfall for grazing and agricultural purposes.

FISCAL YEAR JULY 1955–JUNE 1956

Nevada State Cloud Seeding Committee, Carson City; north board of control, Owyhee project, Nyassa, Oreg., and south board of control, Owyhee project, Homedale, Idaho, clients, and North American Weather Consultants of Idaho, Inc., Goleta, Calif., contractor. In the drainage area above the Owyhee Dam and Humboldt, Pershing, Elko, Lander, and the northern part of Eureka Counties. From November 1, 1955, to May 1956. Conducted to increase precipitation for increased power output.

FISCAL YEAR JULY 1956–JUNE 1957

No reported activity to date.

Report on Cloud-Seeding Activities in Kansas, From 1950–57

FISCAL YEAR JULY 1950–JUNE 1951

The Water Resources Development Corp., Denver, Colo., contractor. In Cheyenne, Rawlins, Decatur, Sherman, Thomas, Sheridan, Wallace, Logan, and Gove Counties. From April 1951 to June 1951. Conducted to increase rainfall for agricultural purposes.

FISCAL YEAR JULY 1951–JUNE 1952

The Water Resources Development Corp., Denver, Colo., contractor. In Cheyenne, Rawlins, Decatur, Sherman, Thomas, Sheridan, Wallace, Logan, and Gove Counties. From August 1951 to October 1951. Conducted to increase rainfall for agricultural purposes.

The North American Weather Consultants, contractor. In Cheyenne, Rawlins, Decatur, Sherman, Thomas, Sheridan, Wallace, Logan, and Gove Counties. From April 1952 to October 1952. Conducted to increase rainfall for agricultural purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In Morton and Seward Counties. From May 1952 to April 1953. Conducted to increase rainfall for agricultural purposes.

FISCAL YEAR JULY 1952–JUNE 1953

The North American Weather Consultants, contractor. In Cheyenne, Rawlins, Decatur, Sherman, Thomas, Sheridan, Wallace, Logan, and Gove Counties. From April 1952 to October 1952. Conducted to increase rainfall for agricultural purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In Morton and Seward Counties. From May 1952 to April 1953. Conducted to increase rainfall for agricultural purposes.

FISCAL YEAR JULY 1953–JUNE 1954

The Water Resources Development Corp., Denver, Colo., contractor. In Butler County, north of the city of El Dorado. From January 1954 to September 1954. Conducted to increase rainfall for agricultural purposes.

The Weather Corp. of America, contractor. In the southeastern corner of the State, including Cherokee and parts of Woodson, Allen, Wilson, Neosho, Crawford, and Labette Counties. From March 1, 1954, to May 30, 1954, and from June 1, 1954, to June 30, 1954. Conducted to increase rainfall for agricultural purposes.

The Water Resources Development Corp., Denver, Colo., contractor. In Comanche County. In July 1953 and October 1953. Conducted to increase rainfall for agricultural purposes.

FISCAL YEAR JULY 1954–JUNE 1955

The Water Resources Development Corp., Denver, Colo., contractor. In Butler County, north of the city of El Dorado. From January 1954 to September 1954. Conducted to increase rainfall for agricultural purposes.

FISCAL YEAR JULY 1955–JUNE 1956

No recorded activity.

FISCAL YEAR JULY 1956–JUNE 1957

The Midland Empire Weather Modification Association, Inc., St. Joseph, Mo., client, and the Water Resources Development Corp., Denver, Colo., contractor. In Nemaha, Brown, and Doniphan Counties. From November 8, 1956, to November 8, 1957. Conducted to increase rainfall for agricultural purposes.

Senator BIBLE. Each of these reports has been furnished to the committee by the Advisory Committee on Weather Control.

I would also like to insert in the record a statement of the Advisory Committee's appropriations and expenditures for the fiscal year 1955 and fiscal year 1956 and fiscal year 1957.

Advisory Committee on Weather Control appropriations and expenditures

Fiscal year	Appropriations	Expenditures to date in round figures
1955	$120,000	$104,000
1956	275,000	251,000
1957	300,000	224,000
Total	695,000	579,000

Senator BIBLE. At this time we will hear from Mr. Robert Elliott, of Pasadena.

STATEMENT OF ROBERT D. ELLIOTT, PRESIDENT OF NORTH AMERICAN WEATHER CONSULTANTS, SANTA BARBARA, CALIF.

Mr. ELLIOTT. I am Robert Elliott, president of North American Weather Consultants. I would like to speak first as vice president of the Weather Control Research Association, because I think I should add something to what Mr. Henderson has already presented with regard to that organization. There were several questions asked about it.

Senator BIBLE. Yes; I have no objection to your doing that. Do you hold some official position with that organization?

Mr. ELLIOTT. I am vice president.

Senator BIBLE. How many vice presidents does it have?

Mr. ELLIOTT. There is only one.

Senator BIBLE. Very well.

Mr. ELLIOTT. I would like to give a partial list of the Weather Control Research Association. They include such organizations as Pacific Gas & Electric; Southern California Edison; California-Oregon Power Co.; Los Angeles Bureau of Water and Power; California Electric Power Co.; East Bay Municipal District; United States Forest Service; National Park Service; Bureau of Reclamation; director of forestry, California; United States Weather Bureau; Corps of Engineers; Los Angeles County Flood Control District; Department of Water Resources of the State of California; Metropolitan Water District; Scanbaiga County Water Organization; Santa Anna River Association; and North American Weather Consultants, my firm; the Water Resources Development Corp., Dr. Krick's firm; the Weather Modification Co.; and another company engaged in weather-modification work.

If you would so desire, we can submit a complete membership list.

Senator BIBLE. I do not think that is necessary. The question was just asked in a general way to find out what type of an association you had, and I think the list that you indicated is representative. I understood there were some 40 individual members, in addition, that belong—farmers, and so on?

Mr. ELLIOTT. There are farmers' groups represented; yes, sir.

Senator BIBLE. I think that is sufficient.

You may proceed, Mr. Elliott, with your statement.

Mr. ELLIOTT. This is my statement on S. 86, as president of North American Weather Consultants of Santa Barbara, Calif.

As a representative of a meteorological consultant firm which has engaged in extensive cloud-seeding activities primarily in western mountain areas during the past 7 years, I can state that S. 86 is of great interest to us.

We, and other meteorologists engaged in weather-engineering activities, are now at a point where we know something about a weather-modification procedure which is potentially of enormous economic benefit. The findings of the President's Advisory Committee on Weather Control have shown the value of snow pack and runoff enhancement through cloud seeding in western mountain watersheds.

This happens to be of particular concern to us, because we specialize in that work. We do a small amount of work in farm areas.

Effectiveness in other areas is poorly known, primarily because of difficulties involved in evaluation of results. But even in the western

watersheds, we realize that the efficiency of our present techniques is limited by gaps in our understanding of the basic meteorological mechanisms involved.

In our opinion, we have thus far obtained only a small glimpse of what lies ahead in weather modification. In order to broaden this view, there must exist greater support for basic and field research than has been the case thus far. The fundamental work done by Project Cirrus, under Langmuir and his coworkers at the General Electric laboratories, laid the groundwork for present techniques. The pioneering efforts of the utility companies, farm groups, and others who have sponsored cloud-seeding projects has furthered the actual engineering application of weather-modification techniques to its present state of usefulness. But now it is time to expand the scope through broadened support and thus to lift the field above its present plateau. Basically, this means bringing more "brains" to bear upon the problem.

As an example of a project where a concerted and coordinated effort is being made by groups possessing different skills and types of knowledge, we have the rather unique Santa Barbara County project. This 3-year project is designed to obtain the maximum amount of information regarding precipitation distribution in an area where the normally used technique of seeding with ground-based silver iodide smoke generators is being employed. The State water resources department has installed and is maintaining 35 record gages in the target area and in various control areas. These gages were loaned by the United States Weather Bureau. The statistical evaluation of results is being done by the Statistics Laboratory of the University of California, at Berkeley. A weather-radar study is being supported by the Advisory Committee. The engineering, logistics, and meteorological control of the seeding operation is being handled by North American Weather Consultants under contract to the county of Santa Barbara. The statistical design is such that certain seedable storms are not seeded but reserved for comparison with seeded storms. The nonseeded storms are selected on a randomized basis. We truly believe that through this combined effort much will be learned concerning the details of effectiveness of cloud seeding under a variety of meteorological conditions.

It is our view that, if S. 86 will provide broadened support for projects of this type—and it is our understanding that it will—then we heartily support it and recommend its passage.

Senator BIBLE. Thank you, Mr. Elliott.

There are just a few questions which occur to me. North American Weather Consultants is an association?

Mr. ELLIOTT. A private meteorological consulting firm.

Senator BIBLE. Composed of a group of individuals?

Mr. ELLIOTT. Yes; a group of meteorologists.

Senator BIBLE. How much of a group?

Mr. ELLIOTT. About 15 professional meteorologists with supporting help, clerical help, and so on.

Senator BIBLE. And your range of activity is where?

Mr. ELLIOTT. Right now we have about eight mountain watershed areas we are seeding over the Western United States and Canada, and we are also engaged in cloud-seeding operations in Iowa.

Our primary activity during the past 7 years has been centered in California, Washington, and Oregon.

Senator BIBLE. And now you are doing some activity in Iowa?

Mr. ELLIOTT. Yes, sir.

Senator BIBLE. Now, you are familiar with the Santa Barbara projects?

Mr. ELLIOTT. Yes, sir; we have seeded there in the past. The new project, the 3-year project, is based on application of the principle of randomization for statistical control, and also additional use of the physical evaluation techniques.

Senator BIBLE. How large a project is it, dollarwise? How much is involved?

Mr. ELLIOTT. Altogether, I would say there is roughly $50,000 a year being spent on it by the various agencies.

Senator BIBLE. And, as I understand it, that is on a voluntary contribution plan?

Mr. ELLIOTT. That is correct. The support is coming from the county of Santa Barbara for the actual seeding, from the State water resources department, from the University of California on evaluation, and at present they are receiving a grant from the National Science Foundation to cover that work.

Of course, the Weather Bureau has contributed the rain gages, and the Advisory Committee is supporting the weather-radar work which is being done by another meteorological firm, Meteorology, Inc.

Senator BIBLE. And it is your definite feeling that there is the need for a further research program as is contemplated in Senate bill 86—you feel that there is much left to be done in this particular area in which you are working?

Mr. ELLIOTT. Well, I think even in our own region on the west coast, where we have had so much success in at least proving out the fundamentals here, I think there is a vast area for improvement there by further research, that we can do better than we are doing now.

Senator BIBLE. How many cloud-seeding projects are there actually, per year, in the State of California; if you know?

Mr. ELLIOTT. Well, roughly, I would say there are 5 or 6 running every year.

Senator BIBLE. Is that up in the Sierras, the Pacific Gas & Electric project?

Mr. ELLIOTT. There are three Pacific Gas & Electric projects on which we are serving as contractor, and the Edison Co. contract, which we are also a contractor on, and the California Electric project, and there are usually several farm projects in the San Joaquin Valley.

Senator BIBLE. These are straight-out rain projects?

Mr. ELLIOTT. Those are straight rain. There is the Santa Clara County project, which has been going for a number of years, which is straight rainfall in the watershed, not snow pack, and the Santa Barbara project, which has been running off and on since 1951, and San Diego County also has had a number of projects, and we are working on one this year.

I might add, by way of clarification, in regard to the Santa Barbara project, that 3 previous years' seeding were evaluated by the State water resources department, in addition to several other projects in the California area, and their reports showed an increase in

precipitation in the target area, which, with the statistics used, was statistically significant. However, it was pointed out that reliance on historical weather data was questionable, and it was suggested that in order to get an absolute statistical proof, it would be necessary to conduct a randomized experiment, where you install a lot of rain gages, then seed some of the storms and reserve other storms for comparison purposes, so that these nonseeded storms are shuffled by a randomizing process amongst the seeded storms in a random way, and that is what is being done in this 3-year project.

Senator BIBLE. When will that project be completed?

Mr. ELLIOTT. This is the first year.

Senator BIBLE. This is the first of the 3 years?

Mr. ELIOTT. This is the first of the 3 years.

Senator BIBLE. Do you have any idea as to the cost and benefit of these California projects you have mentioned? I don't think there is anything in the record, and I would appreciate that it is hard to evaluate.

Mr. ELLIOTT. I might point out, if you increase the precipitation as little as 10 percent, it can mean as much as 100,000 more acre-feet in some of the mountain watershed areas, and an acre-foot of water is worth anywhere from $3 to $10 per acre-foot.

Senator BIBLE. And how much does it cost you to get that?

Mr. ELLIOTT. $20,000 to $30,000 a season.

Senator BIBLE. And for that you get the benefit of 100,000 acre-feet as a rough comparison?

Mr. ELLIOTT. That is correct; if you are effective in increasing precipitation, that is true.

Senator BIBLE. California seems to be the leader in this particular field of cloud seeding, and would have more background for results.

Mr. ELLIOTT. There has been experience in Oregon, also. We have conducted a project in the Cascades for going on 6 years, and also in northern Idaho and eastern Washington.

Senator BIBLE. I think I have no further questions. Thank you very much. I appreciate your being here.

Mr. Krick, we will now hear from you.

If you will just be seated and identify yourself for the purpose of the record.

STATEMENT OF IRVING P. KRICK, PRESIDENT, WATER RESOURCES DEVELOPMENT CORP.

Mr. KRICK. My name is Irving P. Krick. I am president of the Water Resources Development Corp., located at 460 South Broadway, Denver, Colo.

Senator BIBLE. And what is the Water Resources Development Corp.?

Mr. KRICK. The Water Resources Development Corp. was formed in 1950 for the purpose of operating weather modification projects. It evolved from investigations which were carried on at the California Institute of Technology, where I held the chair of meteorology from 1933 to 1948.

Senator BIBLE. You held that chair where?

Mr. KRICK. At the California Institute of Technology at Pasadena, Calif.

Senator BIBLE. Do you have a prepared statement, Mr. Krick?

Mr. KRICK. No, sir; I do not.

Senator BIBLE. You are here testifying at this hearing on Senate bill 86, and we will now hear your views on the bill.

Mr. KRICK. I have read the bill, and I am completely in accord with the statements contained therein and the objectives of the bill.

I feel that the field of weather modification requires extensive research and development to perfect these techniques, and to obtain maximum potential from them.

Our work has involved both the investigation of the fundamental principles and the exploitation of these principles in the field. Through the field experiments that we have conducted, now, which encompass operations in about 27 States and a dozen foreign countries, we feel that the results, as compiled and released recently by the National Advisory Committee on Weather Control, are sound, both from a technical and an economic standpoint, and therefore hold great promise, not only in alleviating some of the water problems in the United States, but elsewhere in the world.

Therefore, as I stated, we are certainly in complete accord with the objectives of Senate bill 86, and would like to go on record with that statement.

Senator BIBLE. Thank you, Mr. Krick.

You say you operate in 14 States. What type of operation do you carry on in those 14 States?

Mr. KRICK. Actually, we have operated in 27 States and a number of foreign countries. Our operations have involved increasing natural precipitation in its various forms, snowfall and rainfall. We have also engaged in the suppression of hail in California, Oregon, and the Province of Alberta, in Canada.

The projects in California and Oregon are now going into their fourth year. The project in Alberta is entering its second year.

Senator BIBLE. How much success have you had in cloud seeding, rainmaking, or snowmaking in the States in which you have operated?

Mr. KRICK. We feel that our success is of the same order of magnitude as the projects that have been evaluated by the Advisory Committee on Weather Control. We have applied, recently, tests which combine both the physical elements of the storms which are seeded and a statistical approach which we feel may ultimately contribute to our ability to assess the operations, both from the standpoint of the technical as well as the economic success.

To be specific, one of our projects which has progressed intermittently since 1951 involves the Columbia River Basin on the United States side, above Grand Coulee Reservoir. This project was first supported by the Bureau of Reclamation, and subsequently by private power interests in the Pacific Northwest.

A recent assessment of those results, based upon a study of the characteristics of the storms involved, indicates a success of the order of 18-percent increase in the natural precipitation, which is of the same order of magnitude as tests made by the National Advisory Committee on Weather Control in areas of the western United States, where the climatic conditions are somewhat similar.

One of our projects in France, in the Alps, where the climatic conditions are also somewhat similar, the engineers of Electricite de

France, which is our client in that area, have arrived at an assessment of results of the order of 24-percent increase, which, again, is of the same general magnitude as the studies progressed by the Orville Committee.

We have also recently made an assessment of some 40 projects in various parts of the world by superimposing the rainfall patterns from each of these projects, and taking an average to indicate our ability to target our effects to a specific area, as well as to increase the natural precipitation, and the results there vary from about 13 to 16 percent, which is again within this general range that has been found by the Presidential Committee.

Senator BIBLE. I note here from the report of the Weather Advisory Committee that you conducted an experiment, several experiments as a matter of fact, in my State, the first one apparently in Elko County, Nev., in 1951.

Would you have any recollection as to the success or failure of that project?

Mr. KRICK. I believe the project exhibited about the same characteristics as other projects in that general area. The difficulty of assessing a project for a single year enters into the problem of dealing with one individual project; but, on the basis of the methods of analysis which have now been developed, where we feel that we have attained a method of projecting the weather patterns prior to cloud-seeding operations, with a degree of accuracy which will permit a very simple type of evaluation, we are in a position to go back through all of of these earlier projects and apply these same techniques.

This involves the application of high-speed electronic computing equipment to a method of long-range weather forecasting which was evolved at the California Institute of Technology in the thirties, and battle tested during World War II.

We have now been able to project the weather patterns by machine, with sufficient accuracy, and completely objectively to a point where we feel that in the future it will be possible to estimate the natural rainfall patterns prior to a cloud-seeding operation, and then make direct comparisons subsequently between the measured rainfall and the projected rainfall, both inside the project areas and in areas outside or unaffected by cloud seeding.

Now this objective has been recognized by all of those working in the cloud-seeding field as probably being the ultimate objective in assessing these results, because the basic problem in evaluation is to be able to distinguish between the amount of rainfall that would have occurred, naturally, as compared to the actual measured rainfall.

We feel that in all of these problems of determining the value of cloud seeding, if we can first project the basic natural weather patterns, we will be able to determine, for example, in drought areas, whether or not cloud seeding will have any value, or whether we can attain a rainfall pattern which will be of economic significance.

There is such a thing as having a technical success, but an economic failure, in marginal areas during drought conditions, when the natural rainfall might not be sufficient even with an increase from cloud seeding to make a crop, so we feel that the basic problem in all of this work is to eventually be able to project the natural weather patterns, and then determine whether or not a cloud-seeding project superimposed on this pattern will be effective.

Senator BIBLE. I want to clear up this one point.

You conducted, according to this report, 2 tests in Elko, Nev., 1 in 1951 and 1 in 1952, and there were tests conducted to increase rainfall for agricultural purposes, as I understand it.

Mr. KRICK. Yes, sir.

Senator BIBLE. Now, did you increase the rainfall, or didn't you increase the rainfall?

Mr. KRICK. It is our view that we did, based upon the analysis made of the rainfall after the operation and comparing these data with the patterns of rainfall that occurred historically with the same storm types.

Senator BIBLE. Would it be within that range of 10 to 15 percent?

Mr. KRICK. Yes, sir; I think it would be.

Senator BIBLE. You do not give any opinion as to whether the costs or benefits were greater?

Mr. KRICK. Not knowing the economic implications in that particular area, I would hesitate to put a direct benefits-to-cost ratio on that operation. But as I understand it, the project was aimed primarily at improving grazing conditions in that area, and I think it would probably be an appropriate study to try to assess the value of additional rainfall to the area in the light of its impact on grazing conditions. But we did not actually make that type of study, so I am not in a position to give a direct figure on what the benefits-to-cost ratios are in connection with that project.

In similar areas, where studies of that nature have been conducted, I think it is safe to say that the benefits do far outweigh the costs.

Senator BIBLE. That determination is made basically, I suppose, by the client that hires you.

Mr. KRICK. That is correct, or some independent agency that he may retain for the purpose of conducting studies of that type.

Senator BIBLE. Thank you, Mr. Krick. Unless you have something else you want to add.

Mr. KRICK. I might add, Senator, for the record, a paper delivered last week at the Missouri Basin Interagency Committee at St. Joseph, Mo., entitled "The Use of High-Speed Electronic Computers for Long-Range Weather Forecasting and Cloud-Seeding Evaluation," which I believe is pertinent to the discussion.

Senator BIBLE. Is this a paper given by yourself?

Mr. KRICK. Yes, sir. I would just include it for the record, without reading it.

Senator BIBLE. We will place it in the record.

(The paper referred to follows:)

THE USE OF HIGH-SPEED ELECTRONIC COMPUTERS FOR LONG-RANGE WEATHER FORECASTING AND CLOUD-SEEDING EVALUATION

WEATHER PROBLEMS FOR ELECTRONIC COMPUTERS

Two items of continuing interest, both in scientific journals and to the public during the past several years, are the development of electronic computers and advances in weather knowledge, both from the standpoint of forecasting and modification. Many of the weather problems being solved today by electronic computers were well beyond the scope of human undertaking just a few years ago.

Meteorology deals with the atmosphere. The atmosphere is constantly in motion; it is compressible; it is made up of many gases, of which one at least, water vapor, is continually varying both in amount and change of state. The

atmosphere is constantly subjected to differential heating on both large and small scales. Thus its behavior pattern is a complex thing.

Practically all human activities are dependent on the weather. So despite its complexity, we try to solve the problem of forecasting events which are taking place in the atmosphere. The human mind is incapable of unraveling its mysteries without the aid of devices such as these new electronic computers.

In addition, we are finding ways to exploit the rainfall potential of the atmosphere and to otherwise modify the weather. Electronic computers are aiding in the assessments of results.

THE PREPARATION OF WEATHER FORECASTS FOR EXTENDED PERIODS

What is an expert weather forecaster? He is a man who has vast experience in determining common, or infrequent, weather developments in the atmosphere. He does this from his background in watching previous but similar developments.

Unlike many finds in the field of astronomy, the forecast was not arrived at by computations. He can draw conclusions from previous similar developments because weather tends to repeat itself. This, of course, is stating the situation in the simplest of terms.

The atmosphere is affected by many complex wave-like movements similar to the waves and tides of the ocean. The disturbances travel around the earth from west to east in rhythmic patterns and obey natural laws. Many of these wave streams were set in motion millions of years ago. Some are being set in motion in a systematic fashion even today. Since they follow an ordered behavior pattern somewhat like the tides, although much more complex, they must be predictable.

As early as the midthirties, it was apparent to our group working at Cal-Tech that these atmospheric waves produced specific patterns of weather in relation to the distribution of the continents and oceans and certain broad-scale features of the atmospheric wind systems.

Our weather today is a function of the weather that has gone before, and of the current forces acting on the atmosphere, so that given sufficient past data and a method of determining any systematic recurrences in the pressure waves in the atmosphere, forecasts for days, years, or even centuries, are feasible.

In the work at Cal-Tech in the thirties, 6-day sequential patterns of pressure-wave systems and their associated weather were discovered and carefully defined. Frequently, and sometimes for several months, these patterns would follow in a systematic progression so that reliable forecasts could be made from 6 days up to sometimes several months in advance.

The real limitation to further development, however, came about as the result of drastic transitions between weather patterns caused by complex wave systems which could not be foreseen.

Methods of forecasting these transitions from one weather pattern to another have been studied during the past 20 years. Now, at last, we have sufficient data punched onto cards for use by the electronic computed so that we can process it rapidly enough to produce dependable predictions before the weather outruns the calendar.

We now have 20 years of appropriate data on cards. The Remington Rand Univac is used in processing these data. This unit is capable of producing day-by-day forecasts for periods several times the length of the data record.

WEATHER-MODIFICATION EVALUATION

Along with new developments in long-range forecasting, the most significant advances in meteorology in the past decade are being made in the field of weather modification.

Langmuir and Schaefer in 1946 discovered that supercooled clouds could be crystallized by introducing artificial nuclei composed of substances which stimulate the process more effectively than natural nuclei. Since that time, developments in cloud physics have progressed rapidly and the science of weather modification has evolved to a completely practical stage.

A discussion of weather modification, along with long-range forecasting, may seem to be covering a diversity of subjects in such a short paper. However, they are closely related.

The primary problem in long-range forecasting is to know what the pattern of weather will be so that human affairs can be related to it.

Perhaps the major problem in the field of weather modification has been evaluation of results. This is basically a function of what the weather would have been without cloud seeding so that variations caused by weather modification can be determined.

In the final analysis, if one can accurately determine upcoming weather and superimpose changes possible through weather modification, activities involving agriculture, hydroelectric operations, the impact of drought, can all be planned realistically and effectively.

Regardless of the technique used, the essential consideration in evaluation of weather modification involves an estimate of what the precipitation would have been had weather-modification activities not been carried out as a basis for comparison with measured precipitation.

Until the beginning of 1956, the public could have been forgiven for being completely confused concerning the whole issue of cloud-seeding evaluation. Findings published in cautious terms by university investigators were often misconstrued and given unjustifiable headlines in the press and were frequently guilty of gross oversimplification.

Statisticians have devoted extremely large amounts of time and money on statistical evaluations. It was relatively easily determined from statistical means that overall average increases from weather-modification operations were of the order from 9 to 30 percent in the direction of an increase.

The determination of increases from individual storms or a refinement on the average increase in various projects proved much more difficult.

The problem was one of looking for, say, a 20-percent increase in a sample of precipitation data when natural variations from a conglomerate of weather patterns were of the order to 200 to 300 percent. The ultimate in refinement to date in this purely statistical approach has been the excellent piece of work achieved by the President's Advisory Committee on Weather Control.

For the first time, following intensive study in the use of a statistical method that cannot be held too much in question, a quantitative measure of cloud-seeding effects was arrived at by that group for rain-increase programs conducted in orographic conditions on the west side of continents. Average increases of 9 to 17 percent were established for a series of Pacific coast projects.

The concentration on these west coast projects resulted from a consideration of the seasonal character of the precipitation patterns in that area, and that these projects have been in operation for a number of years—many since the early 1950's. Even these refined statistical techniques have been inadequate in the assessment of flatland projects in the Central-Eastern United States.

To overcome the inadequacies of purely statistical methods of cloud-seeding evaluation, a consideration of the elements of storms being seeded must be included. Both purely statistical and physical techniques have considerable independent value. This value, however, increases greatly when broad-scale meteorological, as well as physical, information can be integrated and treated statistically.

The use of weather patterns as employed in the preparation of long-range forecasts when adapted to weather modification evaluation efforts, provides one of the best means of accomplishing this objective.

As early as 1948, when our group was conducting its first studies in the field of cloud seeding, such comparisons were made. This involved determinations of the frequencies of various weather patterns and their related precipitation in a specific area.

By studying a large number of cases for each weather pattern, various probabilities of precipitation expectancy for any case of the individual pattern were established.

Consequently, for each weather type as it occurred a probability could be established for the occurrence of the measured amounts of precipitation. By studying these probabilities for a large number of seeded weather patterns, the deviation of the actual precipitation during cloud seeding from that which would have been expected under natural conditions over an extended period of time, was established.

These investigations were very laborious and limited in scope due to the large amount of data analysis necessary. Now that all weather-pattern data are being placed on punched cards so that it is susceptible to analysis by electronic computers, this technique, which takes full advantage of meteorological and physical considerations in a manner than can be realistically treated statistically, makes possible detailed and objective evaluations of individual seeding projects.

The following example, based on a preliminary analysis, illustrates this approach. The Water Resources Development Corp. has operated for the United States portion of the Columbia River Basin above Grand Coulee for several years. In a report of the cloud-seeding potential of this area prepared before the project was undertaken, values of precipitation expected in the basin for each weather pattern were calculated. Subsequently, in the report covering operations carried out in the fall of 1951, it was determined on the basis of weather types occurring during cloud seeding, that the basin average should have been 1.34 inches between September 21 and October 1. This was nearly double the longtime average of 0.68 inch for this period.

The longtime average, of course, is established from the precipitation from all-weather types. The actual precipitation was 1.49 inches. It can readily be seen that a consideration of the weather patterns present confirmed that precipitation should have been well above normal for the period, but still less than the actual amount recorded. Crediting the extra rainfall above that expected from the prevailing weather patterns, must be considered with reservation, for a single case. Refinements, of course, can be made. To start with, many cases can be accumulated. In addition, target and control relationships can be developed, based on rainfall data for the various weather patterns.

For the winter seasons, 1954–55 and 1955–56, when weather-modification operations were carried out for this same basin, the variation of actual precipitation from type expectancies has been made. This has also been done for the same period for control stations, along the Pacific coast, unaffected by cloud-seeding operations. The use of control areas can also point up trends in climatic change resulting from persistencies in the occurrence of certain weather patterns during any particular period. During the 1954–55, 1955–56 seasons, the United States part of the Columbia Basin received 142 percent, as much precipitation as might have been expected from the weather patterns which actually occurred during the operational periods. During the same interval, a group of control stations immediately along the Pacific coast which could not have been directly affected by weather modification, received 124 percent, as much precipitation as might have been expected from the patterns which did occur. There was thus an 18-percent differential in favor of the seeded area, based on the normal distribution of rainfall in both target and control area for this same group of storm types. Excesses over normal expectancies in the control areas imply a climatic trend toward wetter conditions in recent years in this section of the United States.

A similar study is underway in the Midwest. It involves a period from June 20 to October 28, 1956, during which cloud seeding was in progress in eastern Nebraska, Iowa, and Missouri. Precipitation data from North Platte, Nebr., a station not in any weather-modification project during the summer of 1956, has been reviewed in some detail. During the interval investigated, North Platte and that area of Nebraska, were affected by the following North American weather types:

	Cases		*Cases*
Type A	2	Type BA	2
Type AB	4	Type B–D_n	2
Type B	5	Type BN	7

From this distribution of weather patterns, North Platte could have expected 5.80 inches of rain from June 20 through October 28. This is well below the historical average of 8.17 inches of rain for this period at North Platte. However, the actual amount of 6.09 inches was not far different than the 5.80 inches which would have been expected from the weather patterns which occurred. At Kansas City, however, the picture is much more complex. With the extreme drought through the Southwest from which airstreams reach Kansas City, the precipitation was considerably less than that which the prevailing weather patterns would have produced. The weather patterns for this period which, of course, are the same as the ones indicated above for North Platte, should have produced 14.18 inches of rain at Kansas City—again an amount less than the normal of 15.36 inches: 10.03 inches actually occurred.

It is apparent that with the patterns that occurred precipitation was adversely affected by the drying out of airstreams passing from the Gulf of Mexico northward over the drought area. This, of course, suggests that a consideration of the effects of sequences of weather patterns, as well as individual cases, are of importance for extended long-range forecasting or for evaluation of weather modification.

Neither North Platte or Kansas City was in a seeded area during the past summer. Omaha was in a weather-modification project during this period. Despite the fact that over a period of 22 six-day weather-type occurrences North Platte and Kansas City received well below normal precipitation, that at Omaha during this same interval was 13 percent of normal. This strongly suggests an important modification due to cloud seeding. This is used only as an example. However, it shows that, as the operational data accumulate and comprehensive studies of this type can be made by machine techniques, the objective and realistic evaluation of weather-modification operations can be effectively progressed.

The ultimate objective of machine techniques for long-range forecasting is to produce natural precipitation forecasts prior to cloud-seeding operations which can later be compared directly with actual precipitation values, both inside and outside target areas, to assess results. Such tests will have greater impact on the evaluation problem than studies conducted at present, based on data accumulated after operations are in progress.

Machines have another important role in the evaluation of weather-modification operations. All statistical techniques which have been used to date are highly refined to make maximum use of small-number samples. A further research project now underway at the American Institute of Aerological Research consists of the amalgamation of all Water Resources Development Corp.'s operational experience to demonstrate the magnitude and the areal positioning of cloud-seeding effects. This can includes operations for well over a hundred projects for which many thousands of storms have been operated. Over 40 projects, totaling 40 years of operational experience, are already being considered. This is a very definite machine operation which, due to the extremely large sample of data, can supply not only evaluation figures but information as to the efficiency of operational procedures used in many different situations. Due to the large mass of data in a study of this nature, many of the problems arising in small-number statistics no longer apply.

The findings along this approach to date have indicated average target increases in the range from 13 to 16 percent, which agrees well with the value determined from the weather-pattern approach described herein and from the studies of the President's Advisory Committee on Weather Control.

SUMMARY

The paper outlines some of the ways in which the scope of evaluation of weather-modification operations is widening with experience:

1. By improved weather forecasting, in the shorter and longer range fields.
2. By increasing the emphasis placed on physical combined with statistical techniques.
3. By increased quantitative knowledge of the weather associated with the weather types.
4. By accumulation of results of a long series of operated projects.

Results to date lead to optimism concerning the validity of and benefits derived from cloud seeding, and confirm the faith of the commercial groups in the value of their work.

(Additional memorandum and appendixes submitted by Paul J. Caubin, secretary-treasurer, Water Resources Development Corp., 460 South Broadway, Denver 9, Colo., is on file with the committee.)

Senator BIBLE. Thank you very much, Mr. Krick.

Are there other witnesses here who desired to testify this afternoon?

Captain ORVILLE, I understand that you will furnish the staff with the names of witnesses that you might desire to have heard on this matter at a later date?

Captain ORVILLE. That is correct, Mr. Chairman.

Senator BIBLE. If you will do that, after we recess here, with Mr. Huse, I would appreciate it very much.

Is there anyone else in the room, or anyone else that has indicated his intention or desire to be called as a witness?

Mr. OPPENHEIMER. Mr. Chairman, I spoke with your staff member, Mr. Huse, with respect to inserting in the record, if we might, the summaries of data we received on cloud-seeding activities from the four States of Texas, South Dakota, Kansas, and Nevada.

Senator BIBLE. I put those in at the opening of the meeting, possibly before you came in.

Mr. OPPENHEIMER. Thank you, sir.

Senator BIBLE. I don't think they show the results.

Mr. OPPENHEIMER. No; they are factual statements of the activities which went on and which were reported to us.

Senator BIBLE. Have you any companion study that shows the results?

Mr. OPPENHEIMER. No, sir; these were summaries gotten up for the convenience of the committee.

Senator BIBLE. They have been included in the record.

If there is nothing further, we will stand in recess subject to the call of the Chair. It is anticipated that we will complete these hearings within the next 10 days or 2 weeks, and the Chair is hopeful we will have a final meeting on this matter and hearings on this bill the week after next.

Just as soon as the date is firmed up proper notice will be given.

(Whereupon, at 2:30 p. m., the subcommittee adjourned.)

EXPERIMENTAL RESEARCH PROGRAM IN CLOUD MODIFICATION

MONDAY, MAY 13, 1957

UNITED STATES SENATE,
COMMITTEE ON INTERSTATE AND FOREIGN COMMERCE,
SPECIAL SUBCOMMITTEE ON S. 86,
Washington, D. C.

The subcommittee met at 10 a. m., the Honorable Alan Bible, chairman of the special committee, presiding.

Senator YARBOROUGH. The subcommittee will please come to order. I would like to insert into the record at this point, a letter from the chairman of the full committee, Hon. Warren G. Magnuson, appointing me a member of this Subcommittee on S. 86.

(The letter referred to is as follows:)

MAY 6, 1957.

Hon. RALPH W. YARBOROUGH.
United States Senate, Washington, D. C.

DEAR SENATOR: This is to inform you that I am today appointing you as a member of a subcommittee to consider S. 86, to provide for an experimental research program in cloud modification. Public hearings are scheduled for 10 a. m. May 13.

The subcommittee is compared of the following: Senator Alan Bible, chairman; Senator Ralph W. Yarborough, Senator Andrew F. Schoeppel.

Sincerely yours,

WARREN G. MAGNUSON, *Chairman.*

The Special Subcommittee on Senate Bill 86, by Senator Francis Case, here present with this special subcommittee, will resume the hearing that was recessed on March 26, 1957.

Senate 86 is a bill to provide for an experimental research program in cloud modification. There are present today approximately 21 representatives of various organizations and governmental agencies that wish to be heard on this bill.

The chairman of the subcommittee, Senator Alan Bible, has been briefly detained, but will soon be here.

I would like to insert into the record at this point, the comments from the various governmental agencies on S. 86.

(The matter referred to is as follows:)

DEPARTMENT OF AGRICULTURE,
Washington, D. C., May 2, 1957.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
United States Senate.

DEAR SENATOR MAGNUSON: This is in reply to your request of January 11, 1957, for a report on S. 86, a bill to provide for an experimental research program in cloud modification.

The Department opposes the enactment of S. 86.

The bill authorizes the Advisory Committee on Weather Control, for a period of 5 years following the enactment of the bill, to formulate a program of experimental research in the field of cloud modification with special reference to areas in the States that have suffered from shortage of natural rainfall. It also provides that the experimental research program may be carried out by contract with private or public agencies, and through cooperative programs with State agencies. A sum not exceeding $5 million would be appropriated for the accomplishment of this program, provided that of the amount appropriated annually, one-fourth shall be available for contracting and three-fourths for cooperative programs to be matched equally by the States.

We do not advise enactment of the bill, as the broad research program planning can be accomplished by the Advisory Committee on Weather Control without additional authority and without extending its authorized life. Detailed program planning should be done by the agency or agencies that are ultimately given the responsibility for experimentation in this field.

The Bureau of the Budget advises that there is no objection to the submission of this report.

Sincerely yours,

TRUE D. MORSE, *Acting Secretary.*

DEPARTMENT OF THE AIR FORCE,
Washington, March 25, 1957.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
United States Senate.

DEAR MR. CHAIRMAN: Reference is made to your request to the Secretary of Defense for the views of the Department of Defense with respect to S. 86, 85th Congress, a bill to provide for an experimental research program in cloud modification.

The Department of Defense has no objection to the proposed legislation, provided it is understood that it will not be interpreted or construed to require participation in or support by the Department of Defense of the cloud modification experimental program provided by the bill. Such participation or support is considered to be outside the scope of the mission of the Department of Defense.

The Department of Defense would favor a cooperative Federal-State research program in cloud modification, provided: (*a*) the program is conducted by the appropriate nondefense agency of the Federal Government, the States and their universities, and private agencies; and (*b*) the program is truly scientific in nature and places major emphasis and priority on basic and applied research on the cloud physics and meteorological problems which must be solved before there can be sufficient understanding and knowledge to realize any significant potential which may exist for the artificial production of precipitation. The Department of Defense suggests that such a program should be administered by a permanent, interested Federal agency, such as the National Science Foundation, the Department of the Interior, the Department of Agriculture, or the Department of Commerce. This administering Federal agency, with the advice and assistance of the Advisory Commmittee on Weather Control, should formulate, in cooperation with the interested States and groups, a cloud modification research and development program, authorize the expenditure of the Federal portion of the funds for approved programs, and coordinate the program of the various State and local organizations. This suggestion coincides with the statement of policy unanimously adopted by the Advisory Committee on Weather Control at its 15th meeting, February 13, 1957.

The Department of Defense and the United States Weather Bureau have recently completed a joint comprehensive program of experimental research and investigation on cloud and weather modification. This program was terminated because the results obtained with available cloud-seeding techniques were not sufficiently favorable or promising, from the military point of view, to warrant further expenditure of funds, effort, and support facilities. On the basis of the experience gained during this endeavor, however, the Department of Defense would estimate that a minimum of 10 to 20 years devoted to basic and experimental research would be required to realize fully any significant economic benefits from cloud seeding.

The budgetary effect of S. 86 is not determinable at this time.

In view of the urgency for the receipt of this report by your committee, it is being transmitted prior to determination by the Bureau of the Budget as to whether the report is in accord with the program of the President. When such determination is received, you will be so notified.

Sincerely yours,

JAMES H. DOUGLAS, *Under Secretary.*

DEPARTMENT OF THE AIR FORCE,
OFFICE OF THE SECRETARY,
Washington, May 1, 1957.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
United States Senate.

DEAR MR. CHAIRMAN: Reference is made to the report of March 25, 1957, which was transmitted to you by this Department on behalf of the Department of Defense with respect to S. 86, 85th Congress, a bill to provide for an experimental research program in cloud modification.

Inasmuch as the committee had requested that action be expedited, the report was submitted to the committee without a determination by the Bureau of the Budget as to whether it conformed to the program of the President.

This is to inform you that the Bureau of the Budget, on April 26, 1957, advised this Department that it had no objection to the report submitted to you on March 25, 1957.

Sincerely yours,

JOE W. KELLY,
Major General, USAF,
Director, Legislative Liaison.

ATOMIC ENERGY COMMISSION,
Washington, D. C., May 16, 1957.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
United States Senate.

DEAR SENATOR MAGNUSON: Please refer your letter of January 11 in which you requested the comments of the Commission with respect to S. 86, a bill to provide for an experimental research program in cloud modification.

We have reviewed the proposed legislation. The program which it would authorize lies beyond the areas of our primary interest and responsibility. We would expect to participate only to the extent that our services are requested in connection with the supply and handling of radioactive materials.

The research might yield useful information in the field of weather control, but we are unable to evaluate the likelihood of such favorable results.

The Bureau of the Budget has advised us that it has no objection to the submission of this report.

Sincerely yours,

K. E. FIELDS, *General Manager.*

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D. C., April 26, 1957.

Hon. WARREN G. MAGNUSON,
Chairman, Senate Committee on Interstate and Foreign Commerce,
United States Senate, Washington, D. C.

MY DEAR MR. CHAIRMAN: In view of forthcoming consideration by your committee of S. 86, a bill to provide for an experimental research program in cloud modification. I am enclosing herewith for your information a copy of my letter of this date to the House Committee on Interstate and Foreign Commerce, regarding H. R. 3631 and H. R. 5232, bills identical to S. 86.

Sincerely yours,

PERCIVAL F. BBUNDAGE, *Director.*

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EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D. C., April 26, 1957.

Hon. OREN HARRIS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D. C.

DEAR MR. CHAIRMAN: This will respond to your request for the Bureau's views on H. R. 3631 and H. R. 5232, bills to provide for an experimental research program in cloud modification. These bills would authorize and direct the Advisory Committee on Weather Control to formulate a program of experimental research in the field of cloud modification over a period of 5 years and at a cost of not to exceed $5 million.

The Bureau of the Budget recommends against favorable action on either of these bills for the following reasons:

1. Pending receipt of the final report of the Advisory Committe on Weather Control, it would, in our judgment, be premature to authorize an action program which would carry on further activities of the kind that the Committee is specifically charged to evaluate.

2. There appears to be almost unanimous agreement among Federal agencies concerned with weather activities and among responsible bodies of nongovernmental scientific opinion, that both governmental and private experimentation with weather modification has been undertaken without adequate basic research about atmospheric processes. In these circumstances the Bureau believes that additional experimental work on cloud seeding and similar activities should not be undertaken until basic research in cloud physics produces the kind of data upon which sound programs and judgments on weather modification can be developed.

3. The Advisory Committee on Weather Control is a temporary agency which was assigned a one-time objective; namely, evaluation of experiments in weather modification. Because of this fact and the further fact that it is organized along the lines of an interdepartmental coordinating group, it would be inappropriate to vest operating functions in the Committee, particularly on activities of direct interest to the agencies from which the members of the Advisory Committee are appointed.

4. An examination of the programs and legislative authorities of the Weather Bureau, the National Science Foundation, and the Departments of the Interior, Agriculture, and the Air Force leads us to believe that adequate authority already exists to permit appropriate financing of any work on weather modification which it would be in the interest of the Federal Government to perform.

Sincerely yours,

PERCIVAL F. BRUNDAGE, *Director.*

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D. C., May 21, 1957.

Hon. FRANCIS CASE,
United States Senate,
Washington, D. C.

MY DEAR SENATOR CASE: In my letter of April 26 to Chairman Harris, of the House Committee on Interstate and Foreign Commerce, on H. R. 3631 and H. R. 5232, bills to provide for an experimental research program in cloud modification, I indicated that adequate authority now exists in the Federal Government for such further research in weather modification as would be in its interest to perform. You have requested citations to support that statement.

Authority for research in weather modification can be found in the basic legislation of the two agencies most directly interested in such research, the Weather Bureau (49 U. S. C. 603) and National Science Foundation (42 U. S. C. 1861–1875). In addition, as you may know, the Department of the Air Force has some interest in this field and has conducted experiments in weather modification under its basic research authority (5 U. S. C. 628 (a)).

The authority possessed by these agencies would appear to be ample for such efforts as the Federal Government may require in this field.

Sincerely yours,

PERCIVAL BRUNDAGE, *Director.*

THE SECRETARY OF COMMERCE,
Washington, May 10, 1957.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
United States Senate, Washington, D. C.

DEAR MR. CHAIRMAN: Your letter of January 11, 1957, requested the views of this Department with reference to S. 86, a bill "to provide for an experimental research program in cloud modification."

The bill would authorize and direct the Advisory Committee on Weather Control to formulate and conduct, both through contract and, in effect, by a grant-in-aid to State agenceis, a 5-year program of research in cloud modification. Further, an amount not to exceed $5 million is authorized for the program, with the restriction that one-fourth of the annual appropriation should be made available for that part of the program to be accomplished through contract, and three-fourths should be made available for the cooperative program to be matched equally by the States.

A review of the extensive experimentation in cloud seeding which has been undertaken throughout the world indicates that the results to the present time have been inconclusive and indefinite. It is clear also that progress in rainmaking operations, which potentially has the possibility of developing into a technically sound and respected field of meteorological engineering, has been retarded in recent years by the lack of coordination among the diverse experimental actviities carried on by numerous public and private agencies. In addition, it is recognized that a major difficulty has been the fact that there are so few research institutions qualified and equipped to carry out an adequate program of experiments in this field.

The Department believes it would be unsound to undertake further exploitation of arid-region rainmaking before adequate methods have been developed. The history of the many hit-or-miss seedings undertaken during the past 5 years bears out the conclusion that a program based on a number of uncoordinated experiments will tend to delay rather than promote progress in rainmaking techniques.

In view of the foregoing, it is our conviction that a more expeditious and economical approach to the development of weather-modification techniques would be to center responsibility for the planning and coordination of an adequate program in the National Science Foundation and to authorize that Agency to make arrangements for research activities by those private and public institutions that are in a position to make the best use of scientific personnel and facilities available. We are convinced this solution to the problem would result in the required comprehensive program at reasonable cost, and would foster cooperation with private organizations and the States in the development of this important meteorological phenomena.

The Department believes that sufficient authorization to carry out such a program already exists in present legislation governing the activities of the National Science Foundation and other cooperating Federal agencies having an interest in this matter.

For the above reasons, the Department of Commerce recommends against enactment of S. 86.

We have been advised by the Bureau of the Budget that it would interpose no objection to the submission of this report to your committee.

Sincerely yours,

H. C. MCCLELLAN,
Acting Secretary of Commerce.

COMPTROLLER GENERAL OF THE UNITED STATES,
Washington, February 4, 1957.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
United States, Senate.

DEAR MR. CHAIRMAN: Further reference is made to your letter of January 11, 1957, acknowledged January 14, requesting the comments of the General Accounting Office concerning S. 86, 85th Congress, 1st session, entitled "A bill to provide for an experimental research program in cloud modification.

The provisions of S. 86 do not affect the functions of this office, and since we have no special information or knowledge as to the need for or desirability of

the proposed legislation, we make no recommendation with respect to its enactment.

Sincerely yours,

JOSEPH CAMPBELL,
Comptroller General of the United States.

THE SECRETARY OF HEALTH, EDUCATION, AND WELFARE,
Washington, March 26, 1957.

Hon. ALAN BIBLE,
Special Subcommittee Chairman, Interstate and Foreign Commerce Committee, United States Senate, Washington, D. C.

DEAR MR. CHAIRMAN: In response to your invitation of March 21, 1957, to attend the public hearings on S. 86 to be held on March 26 and 28, we have decided not to testify.

Sincerely yours,

ELLIOT L. RICHARDSON, *Acting Secretary.*

DEPARTMENT OF JUSTICE,
Washington, February 25, 1957.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce, United States Senate, Washington, D. C.

DEAR SENATOR: This is in response to your request for the views of the Department of Justice on the bill (S. 86) "to provide for an experimental research program in cloud modification."

The bill would provide that, for a period of 5 years following its effective date, the Advisory Committee on Weather Control would be authorized to formulate a program of experimental research in the field of cloud modification, with special reference to areas in the States that have suffered from shortage of natural rainfall.

The experimental research program would be carried out either by contracts between the advisory committee and private or public agencies and through cooperative programs with State agencies.

An appropriation of $5 million would be authorized to accomplish the program. Out of the amount appropriated annually, one-fourth would be available for that part of the program to be accomplished by contract and three-fourths would be available for the cooperative program to be matched equally by the States.

The act approved August 13, 1953 (69 Stat. 559), establishing the Advisory Committee on Weather Control, provided that the committee would cease to exist 30 days following the furnishing to Congress of its final report, to be submitted not later than June 30, 1956. The termination date of the committee was extended for a period of 2 years or until June 30, 1958, by the act approved July 9, 1956 (70 Stat. 509). The House committee report on the legislation extending the committee, indicated that if extended, the committee plans include the making of "detailed recommendations to the President and the Congress on the extent to which he Federal Government in the future should experiment with, engage in, and regulate activities designed to control the weather" (H. Rept. No. 2424, 84th Cong., 2d sess.).

Whether the bill should be enacted is a matter of policy on which the Department of Justice prefers to express no opinion. However, in view of the June 30, 1958, termination date of the committee, under existing law, it may be advisable, if such is intended, to extend the committee beyond the present termination date of June 30, 1958, by specific provision.

The Bureau of the Budget has advised that there is no objection to the submission of this report.

Sincerely,

WILLIAM P. ROGERS,
Deputy Attorney General.

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., April 29, 1957.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce,
United States Senate, Washington, D. C.

DEAR SENATOR MAGNUSON: This responds to your request for the views of this Department on S. 86, a bill "to provide for an experimental research program in cloud modification."

We recommend the enactment of the bill, provided it is amended to conform with the expression of views contained in this report.

The bill, which would become the Cloud Modification Research Act of 1957, proposes a 5-year experimental research program in the field of weather modification to be formulated and administered by the Advisory Committee on Weather Control. The program would be carried on by contracts between the administering agency and private or public agencies, and through cooperative programs with State agencies, including land-grant colleges. Appropriations would be authorized in the amount of $5 million, of which one-fourth would be available for expenditure on research contracts, and three-fourths would be available for expenditure in the cooperative program with the States in which they would match Federal funds.

In view of the various authorized natural resources program, for which the Department of the Interior is responsible, we have a definite interest in any work which affects water supplies and resources, and we would encourage the undertaking of any reasonable measures which will lead to the alleviation of water shortages, particularly in the arid States of the West, by bringing a supply of water where it is needed when it is needed. For these reasons, we have followed with more than a casual interest the experimental work being conducted in the weather-modification field.

Since the general problem of water supply, involving as it does multi-State river basins and drainage areas, is properly considered as being a problem of national interest and significance, we believe it would be appropriate for the Federal Government to undertake a broad research program in weather modification. It is our opinion that there is now a great need to obtain a better understanding of the basic physical principles involved in the precipitation process. If actual cloud-seeding operations are to be continued, we should know, in the first instance, the mechanism by which natural precipitation occurs and the manner in which cloud nucleation acts. We recognize that at an appropriate time there may be a need for well-controlled, large-scale cloud-seeding experiments to which the basic research data could be applied.

Research of this kind is a long-term program and is a definite action plan. For this reason, we believe that the provisions of the bill can be administered better by a permanent agency of the Government than by a temporary agency such as the Advisory Committee on Weather Control which, under its current authority, is to complete its activities by June 30, 1958. While the effects of weather modification may have an important influence on this Department's operations, we are of the view that the responsibility for this program should not be placed in the Department of the Interior. We recommend, however, that basic research be placed in some agency, such as the National Science Foundation, which is devoted to administering scientific research programs and which has had substantial experience in working with educational institutions and other public and private research organizations. Widespread experimental and productive cloud seeding should perhaps be handled by the Weather Bureau or the Department of Agriculture.

With the uncertainty about the amount of money that might be needed for this purpose, it would be better to authorize such expenditures as might be needed rather than stipulating a $5 million authorization for the proposed program. The amounts of money used would then be determined by budget clearance and Appropriation Committee action.

The Bureau of the Budget has advised that there is no objection to the submission of this report to your committee.

Sincerely yours,

FRED G. AANDAHL,
Assistant Secretary of the Interior.

Senator YARBOROUGH. The first witness is Mr. J. V. Whitfield. Mr. Whitfield, will you please come to the witness table?

STATEMENT OF J. V. WHITFIELD, PRESIDENT, FOREST FARMERS ASSOCIATION

Mr. WHITFIELD. Mr. Chairman and members of the committee, my name is J. V. Whitfield. I live in Wallace, N. C. I am appearing before the committee as president of the Forest Farmers Association, which has its headquarters in Atlanta, Ga.

As an official representative of the Forest Farmers Association, I am here to speak in support of Senate bill 86, which would provide $5 million over a 5-year period for an experimental research program in cloud modification.

As information, the Forest Farmers Association is an organization of private timberland owners in 15 southern States. We are a combination of the larger timberland owners and the small timberland owners. There are some 3,600 individuals and companies affiliated with our association. The majority of these, incidentally, are small owners.

Various members of our group have already seen the results and benefits of limited programs of cloud and weather modification. Further research into the possibilities for weather modification are tremendous, and benefits far exceeding the small expenditure proposed would certainly accrue should this proposed legislation be passed.

Individuals and voluntary groups have supported private weather-modification efforts during the past 10 years, and it is very gratifying to see the Federal Government recognize more fully the possibilities for research in this field.

It is our hope that should this bill be enacted into law that some recognition of the earlier private efforts will be given, particularly as regards allocating research projects to areas which have demonstrated their interest in cloud modification; as well as to areas on the strict basis of need.

The Forest Farmers Association also feels that if S. 86 should be enacted into law that it would be vitally important to take advantage of all early efforts and work on cloud modification where feasible, be they private or public. We are of the opinion that the Advisory Committee on Weather Control, which has had 3 or more years' work devoted to specialized programs in this field, would be a most desirable body to oversee such a program should Senate bill 86 be approved and become law.

To our members who are in the tree-farming and timber-growing business, cloud modification has many implications. It seems to us that cloud and weather modification could offer very great advantages in connection with control of lightning and other forest-fire hazards.

As a farmer, may I say, gentlemen, that I have seen the devastating ravages of hail, and the suppression of hail is also one of the factors that this experiment research should include.

In addition, we have only recently come to realize how fully water can be a critical factor in the growing of trees, and if it is possible to regulate precipitation, even to a limited degree, we can undoubtedly increase our tree growth far beyond present capabilities. These factors alone would seem to justify the inauguration of this program of research as proposed by S. 86; and there are many additional valid reasons for urging such work, too numerous to list.

May I make an observation or two, please? I realize we are economy-minded and should be. I realize that a State which has been classified as a welfare State has to conserve its resources, because if we don't we will follow the history of all welfare States, we will become eventually the farewell State as a result of such expenditures. But water is divided into three categories: Supply, its usefulness, and its navigability. We are dealing in this cloud modification program with supply of water.

Now, it has been estimated that nine times the quantity of water that we have in our rivers pass over the United States in the form of clouds. We also must remember that we solve problems of this type by research. General Motors appropriates $35 million yearly for research. Well, surely as vital an ingredient as water is to the world, to every nation—because nations have fallen because of lack of it and because of conservation policies that were inimical to such—surely the United States Government knows the difference between just spending money and to spend money to protect its future welfare.

Senator CASE. Mr. Chairman.

Senator BIBLE. Senator Case.

Senator CASE. I would like to ask you a question or two. I am interested in the fact that you are president of the Forest Farmers Association, Mr. Whitfield. What is the Forest Farmers Association, itself, what does it seek to do?

Mr. WHITFIELD. We seek to protect the interest of the timberland owner.

Senator CASE. Are you converting land into the growth of trees which has been devoted to more traditional crops?

Mr. WHITFIELD. That is one phase. We are trying to protect those industries that make their livelihood out of the tree and particularly the small timberland owner, the little fellow has to be protected in his interests in growing trees.

Senator CASE. I was wondering whether or not you see an increase in rainfall where trees are being grown for those purposes, the possibility that an increase in rainfall might result in growing more trees that would be suitable for the production of woodpulp?

Mr. WHITFIELD. That is it; yes, sir. You say we might grow more trees suitable for woodpulp?

Senator CASE. For woodpulp.

Mr. WHITFIELD. Yes. You see, we have during the past 15 or 20 years, the pulp companies have moved south because of the timber supply there, and they are acquiring large acres of land and producing pulp for themselves.

Senator CASE. So to that extent it would mean the encouragement of a crop in which we have a short supply, perhaps?

Mr. WHITFIELD. That is it exactly.

Senator CASE. I also noticed, Mr. Whitfield, that you referred to lightning suppression. Are you familiar with the so-called Operation Skyfire which the United States Forest Service is conducting in some of the Northwest States?

Mr. WHITFIELD. No, sir; I am not.

Senator CASE. Operation Skyfire is a cloud seeding project——

Mr. WHITFIELD. I beg your pardon; I know of it.

Senator CASE. You know of it?

Mr. WHITFIELD. Yes, I know of it, yes, sir.

Senator CASE. Does the Department of Agriculture or the Forest Service conduct that in your area at all?

Mr. WHITFIELD. Not yet. We hope for it.

Senator CASE. You hope that it might?

Mr. WHITFIELD. Yes, sir.

Senator CASE. Do you have lightning in connection with your storms in the south?

Mr. WHITFIELD. Yes, we do. Hail is one of the big problems particularly in the Tobacco Belt, and suppression of hail—research into the suppression of hail is rendered invaluable aid to the farmers. Of course, we know what lightning does to setting fires.

Senator CASE. Later when we have some of these witnesses who are scientists or who have worked in this field on cloud modification, I hope that they may give for the record a little of the technique that would be followed for the different purposes that you might seek in cloud modification, such as hail reduction and lightning suppression, fog dispersion, and the like.

Senator BIBLE. I think that is a valuable point. I hope the scientists in the room will make due note and cover these points in their testimony.

Mr. WHITFIELD. I will just finish the paragraph.

The membership of the Forest Farmers Association has instructed me to inform you of their deep interest and support of this proposed legislation, and to urge your consideration to recommending its adoption by the Senate when this committee makes its report.

May I emphasize one more time there is such a thing as false economy and anything that would develop the resources of this Nation and protect our water supply, to deny that would be false economy, because it is upon the resources of the Nation that we get the taxes to run our Government.

I appreciate the opportunity of presenting these views, and the committee's courtesy in hearing me is appreciated.

Senator BIBLE. Thank you, Mr. Whitfield. Possibly there are some questions.

Senator YARBOROUGH. Mr. Whitfield, in what States does your association have membership?

Senator BIBLE. The southern and border States.

Senator YARBOROUGH. That is primarily, as I understand it, the forest farmers and not the farmers of conventional agricultural crops?

Mr. WHITFIELD. No. Of course, most of the small owners, I would say 80 percent of our membership, own a thousand acres of timberland or less, so consequently they also are farmers.

Senator YARBOROUGH. In your State of North Carolina, how long does it take to grow a crop of pulp, pine timber?

Mr. WHITFIELD. We estimate that you can start cutting from 15 to 20 years after it is planted. About 20 years, I would say.

Senator YARBOROUGH. What effect does drought have on the growth of this timber?

Mr. WHITFIELD. It slows the timber growth.

Senator YARBOROUGH. What effect would an increase of rainfall have, would it shorten the number of years?

Mr. WHITFIELD. Yes, it would shorten the number of years.

Senator YARBOROUGH. At which the timber could reach an age at at which it could be properly harvested?

Mr. WHITFIELD. That is correct.

Senator YARBOROUGH. I have no further questions.

Senator BIBLE. At this point, I would like to insert in the record, a letter I received from Mr. Herschel D. Newsom, Master of the National Grange, Washington, D. C.

(The letter is as follows:)

NATIONAL GRANGE,
Washington, D. C., May 13, 1957.

Senator ALAN BIBLE,
Chairman, Senate Subcommittee on Weather Control,
Interstate and Foreign Commerce Committee,
Washington, D. C.

DEAR SENATOR BIBLE: The National Grange favors in principle the idea of expanded research in the field of weather control substantially as provided in S. 86 now being considered by your subcommittee. Our viewpoint concerning this question stems from the policy of the National Grange developed by its delegate body at Cleveland, Ohio, in November 1955, which reads as follows:

"Research—The Federal Government should assume vigorous leadership and responsibility in the study and research in the field of maximum water development and use, including rainmaking possibilities, the conversion of sea water to fresh water, the use of sea water for industrial water needs, and the survey of ground water resources and underground water storage possibilities."

Farmers and others have an enormous stake in the possible outcome of research in the field of weather control. It is for this reason that the National Grange believes that the authorization of $5 million over a 5-year period for this type of research seems to be entirely reasonable.

We are not, however, in a position to make firm recommendations concerning who should receive the appropriation and administer the program, believing that your subcommittee is in a better position than we to make this determination.

We would caution, however, that in view of the diversified interests in this field, and because of its paramount importance to many segments of our Nation, the Congress would be wise to think in terms of who is best qualified to guide the proposed program in a well coordinated manner, so that it will result in the greatest possible benefits to all concerned.

We would be honored if the above viewpoint could be made a part of the hearing record.

Respectfully yours,

HERSCHEL D. NEWSOM, *Master.*

Senator BIBLE. We have with us Congressman Hull, of Missouri. We are happy to recognize you now. I believe you told me you had someone from your good State that wanted to testify on this particular legislation.

Mr. HULL. Mr. Chairman, I appreciate this opportunity of being with you again and I want to thank you for your courtesy and kindness in letting my constituent appear before you. I have a committee meeting over in Public Works where we are taking up the flood-control omnibus bill this morning.

I have with me this morning Mr. Larry Ehlert, St. Joseph, president of the Midland Cloud Modification Association, who has spent many hours of his own time in the interest of this particular program. I desire to present to you Mr. Ehlert who has a statement in support of S. 86.

Senator BIBLE. Thank you, Congressman Hull.

Mr. Ehlert, we appreciate having you with us. Do you have a prepared statement? Would you furnish it to the committee?

Mr. EHLERT. I have presented a part of it. I would like to add that as a supplement to the statement I sent you last week.

Senator BIBLE. Very well, you may proceed.

STATEMENT OF LARRY EHLERT, PRESIDENT, MIDLAND WEATHER MODIFICATION ASSOCIATION

Mr. EHLERT. Honorable Senator Bible and subcommittee members, I am appearing here as vice president of the Chamber of Commerce of the City of St. Joseph, Mo., as chairman of Operation Rainfall, South Side Commerce Club, St. Joseph, Mo., and as president of the Midland Empire Weather Modification Association, Inc., which is composed of 2 counties in Missouri, 3 counties in Kansas, and 2 counties in Nebraska. This area is composed of 2,186,600 acres of good farmland and wonderful people. In the past several years, due to lack of rainfall, we have been in trouble not only on our farms but in the towns and cities in this area.

I might divert just a little bit. These titles are my pay for doing the job I am doing. Our pay is mighty poor out there, so they just give us more titles.

I assume that you gentlemen of this committee are interested in knowing the thinking of the folks out in that area, regarding the drought conditions and what can be done about it. I feel that I am in a position to speak for the hundreds of people out there that have put their money and time on the only program offered for some chance of correcting the extremely dry conditions but also some hope of preventing it from happening again. My testimony comes from the grassroots of the Midwest and needless to say dry grassroots for the past several years.

The people for whom I speak are the people that have worked without pay on getting their towns and counties organized into groups to help themselves. They have given of their money plus their time to get cloud-seeding projects into operation. These same people are the very pioneers, they are the workhorses so to speak, they have not only helped on cloud-seeding projects, but they are the very leaders in their communities on this project and others that have merit.

Senator BIBLE. Have you actually undertaken cloud-seeding projects in this particular area?

Mr. EHLERT. Yes. The Midland Empire Weather Association is under contract with 2 counties in Missouri, 3 counties in Kansas, and 2 counties in Nebraska, the effective date being November 8, 1956, for 1 year continuous operation into 1957.

Senator BIBLE. Have you come up with any particular conclusions from the results of those contracts that you have with those various counties?

Mr. EHLERT. Yes.

Senator BIBLE. Perhaps you develop that in your statement. If you do, pardon my interruption.

Mr. EHLERT. No; I do not develop that. I am very happy to say at the present time the State of Missouri, our area at least, we are in the best condition that we have been in several years, from the standpoint of moisture.

Senator BIBLE. Is that due to cloud seeding or due simply to an act of God?

Mr. EHLERT. I am not in position to answer that because we do not have the necessary evaluation in the Midwest. I would like to add here that I think it is most important that we get the necessary evaluation of these projects in operation, so that we may know how much good we are getting from the projects.

Senator BIBLE. Actually the first time you started cloud seeding and weather modification projects in this particular area was November of last year, 1956?

Mr. EHLERT. Yes, sir.

Senator BIBLE. You had done nothing earlier than that period of time?

Mr. EHLERT. No, sir. Just in the fall of 1956.

Senator BIBLE. I can appreciate that, that is hardly a sufficient period of time to have any conclusive results.

Senator Case, have you a question?

Senator CASE. Is the Advisory Committee on Weather Control evaluating or in the process of evaluating and getting records from your operations there?

Mr. EHLERT. Yes, sir; they are getting the statistics from the area.

Senator CASE. And in due time the Advisory Committee will be able to give its appraisal of the results?

Mr. EHLERT. Yes, sir.

I feel it is very important in our area. We have spent hundreds of hours of work to help ourselves, and a great amount of work has been done in the city of St. Joseph and the entire trade area which includes part of Nebraska, Kansas, and Missouri. I feel that it is the responsibility of the Federal Government, through the Advisory Committee, to give us the full facts. We out there feel that we can help ourselves if we know how to do so.

It might be mentioned here that Representative W. R. Hull has done a great deal of work on this same project and maybe you would like to ask him later what his views are.

Senator BIBLE. He testified on this bill at the first hearing that we held and made a very able statement.

Mr. EHLERT. As he stated, we have the mutual interests out in northwest Missouri, Kansas, and Nebraska. I might mention that our city of St. Joe is a town of 80,000 people, we are primarily an agricultural city. We depend entirely on agriculture for our welfare. At the present time our packing industry is 30 percent short of a year ago.

I talked with the railroads recently, and their loadings are off about 30 percent in our city. We have been very drastically affected by the dry years in the past five. As mentioned in my testimony here I have given you a sheet showing that 1956 was the dryest year on record and that we think is part of our trouble.

Any other question, or shall I proceed?

Senator BIBLE. You may complete your statement.

Mr. EHLERT. I will continue with my statement.

As I mentioned, it has been a great pleasure to work with such people that are looking for ways and means to help themselves out of a very bad dry situation and looking for ways to prevent, if possible, the damaging effects of another severe drought.

You might ask what have been the conditions out there. You gentlemen know better than I, how much money the Federal and State

Governments have spent for drought relief in the Midwest and Great Plains areas in the last 10 years.

In going over the Weather Bureau records (sheet attached) since 1910, we find that for the period 1910–20, average rainfall was 31.64 inches, 1920–30 average rainfall was 36.40 inches, 1930–40 average rainfall was 31.23 inches, and 1940–50 the average was 37.79. For the past 7 years, 1950 through 1956, our average was only 31.36 and the 1956 only 22.99 inches.

To sum it up our real problem is only 6 inches of rainfall over an average of 10 years is what is causing the disastrous droughts and all the effects to our people. The effects I know you gentlemen are very well aware of.

Out in our country we call it the dirty thirties. We find that our rainfall was only 6 inches less than that period of prosperity we had, the period of 1940 to 1950, in our area. It is a matter of 6 inches that we did not get over a10-year average that caused our trouble. If there is any way that this can be corrected, I think we in the Midwest area and Great Plains could do a mighty fine job of not asking for drought relief, if we get this extra 6 inches. I might say that drought relief in our area is a little bit like locking the barn door after the horse is stolen. We would like to prevent it if we could.

Back to my statement. Therefore, we do urge the passing of S. 86 in its present form and allow the Advisory Committee on Weather Control to continue the good work that they are doing and, by all means, expand as far as possible the work that is being done in the areas in which cloud-seeding operations are now in progress. We feel that this committee is made up of very able men that will have the cooperation of the universities and land-grant colleges to the degree that we will be able to get the necessary information as soon as possible.

Inasmuch as we do have large areas under cloud-seeding projects and the people in these areas have put up quite large sums of money for the operations of cloud seeding, we feel that the Federal Government could, through the Advisory Committee on Weather Control, gather a lot of the necessary data and information during the next 5 years if they would evaluate what is being done in these target areas already in operation.

Yes, gentlemen, as I see it, this weather-control study and research is too great a project for any one State. Therefore, the passing of S. 86 would give some of the information to all the people of all the States.

Certainly water is one of America's greatest assets, and I understand we are using about 250 gallons a day for every man, woman, and child in America. If there is a chance of getting additional water from above, from the clouds that move over us, let's explore every possibility of getting it before we say it can't be done. I feel that with the passage of S. 86 in its present form and with 5 years' additional research in the field we should have a lot more answers than we now have.

As I see it, if there are any benefits to be had from cloud seeding in project like ours, it would only be good business to go ahead and get the benefits and relieve the drought while the research is being done.

Senator BIBLE. Thank you very much, Mr. Ehlert. I think that is a very able statement. Senator Schoeppel, have you any questions?

Senator SCHOEPPEL. I have no further questions.

Senator BIBLE. Senator Case, do you desire to question Mr. Ehlert?

Senator CASE. I have no questions, but I think this printed supplement should be in the record.

Senator BIBLE. The printed supplement, entitled "What Area Bankers Think of Cloud Seeding," submitted in connection with Mr. Ehlert's statement to this committee, will be made a part of the record.

Mr. EHLERT. This information that I have is just to illustrate the confusion that exists in our area. I think that it is the responsibility of the Federal Government to clear it up and find out how good or bad is this project. Let's get the facts and go forward from there.

Senator BIBLE. Thank you. Senator Yarborough, do you have any questions?

Senator YARBOROUGH. No questions.

Senator BIBLE. Thank you very much, Mr. Ehlert. The committee thanks both you and Congressman Hull.

(The document above referred to is as follows:)

WHAT AREA BANKERS THINK OF CLOUD SEEDING

"As president of the St. Joseph Clearing House, I attended many meetings last summer concerning this project and became convinced after studying the matter that it is a worthwhile program * * * It is too early to definitely make up our minds as to whether or not the program was successful, but we certainly think it is worthwhile to give it a fair trial."—R. E. WALES, executive vice president, Tootle National, St. Joseph.

"The drought in this area, as you know, was quite severe up until about March 15. Soon after that time we had enjoyed ample rainfall in accordance with Dr. Krick's forecast, although in my opinion, he cannot take credit for the increased amount since it was general throughout the Great Plains States. Everyone is very happy that the rain fell no matter who or what was the cause."—EDWIN B. WRIGHT, president, Drovers & Merchants Bank, St. Joseph.

"It is my personal opinion that it has merit, and I believe that anyone would agree, that for the small cost involved, they cannot afford to be without it. I have seen definite figures showing that where the plan was in operation last year, they did receive an appreciable amount of moisture more than normal for the area. This is a scientific process and, in my opinion, has been proven successful."—THOS. J. MCCULLOUGH, president, First Stock Yards Bank, South St. Joseph.

"Yes, we entered into this thing here, I would say, in a big way * * * Here it was more or less grabbing at a straw in a drought-stricken area * * * I was active in promoting the project in this part of the county and I think every banker in the county did some work * * * as well as donating money. We felt * * * that at some time we had 'shot' a $10 or $20 bill in a more foolish way than this looked to be * * * We wonder here if this seeding helped us in the last 2 weeks (early April) * * * as our rainfall here seemed to be heavier than most places in northeast Kansas."—M. F. MOCK, president, Farmers State, Sabetha, Kans.

"There was no concerted drive here to raise funds, principally because neither our farmers nor our townspeople were sold on the plan * * * We have had a good many disparaging remarks from farmers, and I do not recall hearing a single favorable word for the project."—H. W. WILSON, president, Home State, Horton, Kans.

"I have nothing to say in disparagement of the program, but the results seemed to be negligible until nature was ready to bring the rain in good quantity as it has done * * * It appears to me that little credit is being given to the project by the farmers and others to whom I have talked."—B. B. NORRIS, president, Bank of Horton, Kans.

"It is too early to evaluate the measure of success on this venture, but our moisture supply at this writing (March 27) is very much above what it has been the last 2 years. If our money has been spent in vain on this project, we can still credit it to the cause of research, without which we would make very little advancement."—HARLIN L. SCHRAM, President, Morrill & Janes Bank, Hiawatha, Kans.

"We seem to be in a period of 'wait and see.' Naturally, some feeling of skepticism is held among our farmers * * * and the burden of proof is now on the cloud seed operators"—A. A. WOLFFGANG, president, First National, Wetmore, Kans.

"When we were approached * * * I was ready to take a chance on anything * * * I never like to condemn anything new that comes out, as I am reminded that many of our early inventors (Franklin, Whitney, Fulton, Edison, and others) were called crazy by their neighbors."—GEORGE H. OSGOOD, president, First State, White Cloud, Kans.

"This project is rather new, and while response has been good, it has been given mostly on a 'doubting Thomas' consideration."—C. R. CASSITY, president, Rushville (Mo.) State.

"If we have a normal amount of rainfall this year, I don't believe the farmers will go along with the program for another year. I think they can increase the rainfall, but I don't know if they can increase it to the degree they claim."—O. DAVID MCCAULEY, president, Bank of Robinson, Kans.

"Many of our farmers contributed wholeheartedly and firmly believe that the program is workable and has good possibilities. Others contributed * * * feeling that since the cost is so little, they had nothing to lose * * *. Even if we get sufficient moisture, the question will still arise as to how much of this rainfall can be attributed to cloud seeding."—DAN J. DREILING, president, Citizens State, Seneca, Kans.

"The general belief of the farmers in this area is that first we need some clouds and providing we do have clouds with favorable conditions, the cloud seeding will produce added rainfall. They do not believe, however, that our cloud seeding project will guarantee a full crop."—BURTON L. LOHMULLER, president, First National, Centralia, Kans.

"Science has definitely convinced me that it is possible to produce moisture by seeding the proper type of clouds. However, the procedure being used in the experiment, in my judgment, is debatable. * * * The farmers of the area are quite skeptical, but they say: * * * 'We can't afford not to support the project'."—NORMAN SAYLOR, Jr., president, Morrill (Kans.) State.

"As to the reaction at the present time, I would say it falls into three classes—the disbelievers, the doubters and the enthusiastic believers. The average farmer takes the position that the cost is so small they can't afford not to try it. If the territory receives an increase in rainfall this summer over surrounding territories, the natural skepticism of the average farmer would be overcome. Meanwhile, the skeptics are in the majority."—N. C. STEANSON, president, First National, Troy, Kans.

"Genral opinion in this area seems to be about equally divided * * * If we do have a good season, we will think that seeding might have helped and be afraid not to subscribe again."—E. C. STOKES, cashier, Farmers State, Fairview, Kans.

Senator BIBLE. The next witness is Mr. Kalmar, of the Gair Woodlands Corp., Savannah, Ga.

Mr. KALMAR. Mr. Chairman.

Senator BIBLE. Glad to have you with us. Do you have a prepared statement?

Mr. KALMAR. Yes, sir.

Senator BIBLE. Thank you, you may proceed.

STATEMENT OF L. F. KALMAR, GAIR WOODLANDS CORP., SAVANNAH, GA.

Mr. KALMAR. My name is L. F. Kalmar, and I am employed as a forester with Gair Woodlands Corp., of Savannah, Ga.

Speaking strictly as a forester from the Southeast, I would like to state my reasons for believing that an experimental research program in cloud modification, such as one which would be provided by Senate bill 86, would be desirable. Rather than attempt to evaluate present techniques of cloud modification, I would like to point out that it

would be of immeasurable value to our forest resources, if we could develop, through field research, a technique that would induce or increase anticipated, natural, rainfall.

As you know, the southeastern section of the United States was subjected to severe drought conditions for the past several years. During this period of time, millions of dollars worth of timber was burned in a rash of disastrous forest fires on private, public, and industrial ownerships. These fires caused severe damage because the subnormal rainfall for this area was insufficient to keep ponds, swamps, branches, or flat areas filled with water and the ground water table was at a record low in some States. When the fires occurred, under these drought conditions, the job of suppressing them was, in many cases, impossible. The common fire suppression tactic in this section of heading a fire into a swamp or bay area could not be practiced because these areas were dry and would burn more severely than the ridge areas.

This heavy fire loss must be attributed directly to deficient rainfall and not, in any way, to the lack of preparation or suppression efforts on the part of private, public, or industrial ownerships. Actually, these ownerships are presently better equipped to cope with forest fires than at any other time in the past.

Less spectacular but even more disastrous were the timber losses suffered from attack by insects such as the ipps and turpentine beetles. Trees were weakened by lack of water during the prolonged periods of drought and became susceptible to insect attack resulting in extensive damage throughout the Southeast. It should be pointed out that the insects are also present in the forests during years of normal rainfall but are content to work on tree branches and do not damage vigorously growing trees.

Probably greater still than the combined losses to our forest resources resulting from fire and insects was the loss in tree growth during our periods of drought. Trees require an abundance of moisture to make optimum growth; during summer droughts they are virtually at a standstill. In view of the constantly increasing demand on our forest products, we cannot afford this growth loss if we intend to maintain the necessary balance between growth and drain.

Another point that possibly does not rate with the others mentioned from a monetary standpoint but is nonetheless important, is the loss to our fish and wildlife population that can be directly attributed to deficient rainfall.

According to the American Meteorological Society, the "extreme natural variability" of rain makes evaluation of the effects of cloud seeding difficult and inconclusive. But the society agrees that there is good reason to believe that improved returns from cloud seeding will result from a sound experimental approach. If there is this possibility of obtaining favorable results from cloud modification, I would like to state again that I believe the immeasurable value to our forest resources that would accrue from employing a successful technique would most certainly justify a field research program of proportions.

The Water Resources Development Corp. of Denver, Colo., contracted with 12 counties in south Georgia for a period of 1 year—April 1955 to April 1956—to provide cloud modification service using

silver iodide generators. The area serviced, with the exception of one county, experienced one of its most successful crop seasons, and this was of significance because drought conditions appeared to persist in adjacent counties outside of the project area. Whether or not this project received proper technical evaluation or whether or not it was possible to evaluate it at all is not known by me. I do know by hearing expressions from the various county project representatives at a meeting that about 90 percent of them were pleased with the results obtained.

I believe that the past efforts of weather modification corporations such as Water Resources Development Corp. should receive recognition for the pioneer work that they have performed. They undoubtedly obtained a wealth of information about the sectors in which they have operated and could continue, on an experimental basis in the field, to learn much more about the weather peculiar to these sections.

It appears to me that short-period evaluations of any cloud modification program would be of little or no value and would not tend to prove or disprove merits of such projects. I earnestly believe that a 5-year program such as would be provided for by Senate bill 86 would supply us with many answers and possibly even point to a solution in providing significant changes in precipitation occurrence.

Senator BIBLE. Thank you very much, Mr. Kalmar. Senator Schoeppel?

Senator SCHOEPPEL. Mr. Kalmar, down in your State of Georgia and in your area, as you indicate there were experiments on this type of process?

Mr. KALMAR. Yes, sir.

Senator SCHOEPPEL. Do you know whether there is any central clearing point in your State where they have reported the success or the apparent failures of these experiments? Do they log what they have been doing so that they might be of some value in compiling statistics all over the country?

Mr. KALMAR. I do not think that there is. I will say this, that there was an attempt made on this particular project that I mentioned, and one in Florida, to form an evaluation committee. I believe, however, that the substance of the evaluation was inconclusive. I frankly do not believe that there is a satisfactory method by which you can evaluate these projects at the present time. I think that should be a part of this experimental program. There is such a variance from one area to the other in the amount of rainfall that you get during any one period. I think our methods of measurement of rainfall should be standardized so that we would know what we are talking about when we mention the amount of rainfall.

Senator SCHOEPPEL. Thank you very much.

Senator BIBLE. Senator Yarborough, do you desire to question Mr. Kalmar?

Senator YARBOROUGH. Mr. Kalmar, during Mr. Whitfield's testimony—I believe you heard it here this morning?

Mr. KALMAR. Yes, sir.

Senator YARBOROUGH. Hope was expressed that a weather modification program might offer advantages in control of lightning and also control of hailstorms. Have you done any work in that regard, have any statistics been compiled in your area, have there been any

experimental efforts to modify the incidence of lightning or the incidence of hailstorms?

Mr. KALMAR. No, sir. Mr. Whitfield may be better equipped to provide statistics on lightning-caused fires in our area. I have no data at this time. To my knowledge there was no work or projects on lightning suppression or hail suppression in our area.

Senator YARBOROUGH. I presume you have timber losses from tornadoes in that area also?

Mr. KALMAR. We do.

Senator YARBOROUGH. Senator Bible, in your request to the scientists when they testify that they give us the benefit of their observations on the control of incidence of lightning or hailstorm, I would suggest that they also give use the benefit of their opinions relative to weather modifications as it affects the incidence of tornadoes and their destructive effects.

How long in your area in Savannah, Ga., does it take to grow a crop of pulp pine timber to where it is suitable for use in a paper mill, in a year of your average annual rainfall?

Mr. KALMAR. I think the range Mr. Whitfield mentioned of 15 to 20 years was good.

Senator YARBOROUGH. That was for North Carolina. Would that apply to Savannah, Ga.?

Mr. KALMAR. I think possibly our rotation would be somewhat shorter.

Senator YARBOROUGH. Do you have any areas in Georgia that grow crops in 10 to 12 years?

Mr. KALMAR. On specific sites. It depends on the soil quality, of course. We have been able to make a merchantable cut in plantations on 10-year-old trees.

Senator YARBOROUGH. No further questions.

Senator BIBLE. Thank you. Senator Case?

Senator CASE. I have no questions.

Senator BIBLE. Thank you very much, Mr. Kalmar. We would like to hear from Dr. Schaefer, Vincent J. Schaefer, director of research, the Munitalp Foundation, Inc., Schenectady, N. Y.

The committee is honored to have a scientist of your standing testify on S. 86. You may proceed.

STATEMENT OF VINCENT J. SCHAEFER, DIRECTOR OF RESEARCH, THE MUNITALP FOUNDATION, INC., SCHENECTADY, N. Y.

Dr. SCHAEFER. Thank you. Mr. Chairman and members of the committee, my name is Vincent Schaefer. I am director of research for the Munitalp Foundation, Inc. I am appearing before the committee to speak in favor of Senate bill S. 86 which is related to the encouragement of research and the advancement of knowledge in the field of cloud seeding and other related efforts now called weather modification.

The Munitalp Foundation is a private, nonprofit organization sponsoring pure research in meteorology. I have been engaged in the development of its program in the fields of atmospheric physics and chemistry and experimental meteorology for the past 5 years. Pre-

vious to this time I was a research associate in the General Electric Research Laboratory at Schenectady, N. Y.

Senator CASE. Mr. Chairman, I wonder if you would indulge me to say at this time that those of us who have been following this matter of cloud modification for some time recognize Dr. Schaefer as the real pioneer in this field. It was he who worked with Dr. Langmuir in the epochal work that was done by General Electric. I think their work started as a result of a research project for defense during the war when we were studying the possibilities of smoke clouds and what affected cloud formation.

They got into this field which has had some rather dramatic instances, at least, and I think the record should show that Dr. Schaefer is one who has had a very great part to play in this whole work and is a true pioneer.

Senator BIBLE. Thank you, Senator Case. We are glad to have the record evidence that additional qualification.

Dr. SCHAEFER. One of the very important things in this field is the great need, in my opinion, for more basic research in the whole field of atmospheric physics, chemistry, and meteorology. We have greatly suffered, because we haven't had enough of this kind of work along these lines.

For more than 5 years I have been urging the more widespread use of the facilities of land-grant colleges, because I think very definitely that every land-grant college in the country should have at least one person on its faculty who has a sincere interest in this problem, and I would hope that this would then lead to developing a nucleus so that in the various States, having problems along the general line of the subject we are discussing here, they would eventually be able to develop basic ideas and come up with significant items of progress which will give us the kind of information that is greatly needed in solving some of the extremely complex problems we have at the present time and trying to evaluate the results of such activities.

I am sure that as this hearing goes on, you will hear time after time the statement that it is difficult to carry out evaluation. This is very true, and I think one of the great troubles at the present time is that there has been far too little field observation, field experimentation under supervision, and active participation by research scientists who are qualified to make contributions in this field.

I think S. 86 should go a long way toward filling this need, and I think, for one, and this is only my personal opinion, that unless something along this line is carried out, we are in a real danger of having other countries take over the progress along the various lines that are certainly needed to be carried through to final completion.

We can find many cases where unusual claims have been made, and in some cases ridiculous claims, as to what has happened in the field. One reason why such claims have been made is because there are few people to refute such claims who are in a position to say that they have a better answer. I hope that one of the things that we finally end up with in trying to develop an orderly progress in this general field of activity, is that we do not lose what we have gained by the kind of organization which we have enjoyed in the role of the Advisory Committee on Weather Control.

For the first time in the past 2 or 3 years we have seen a certain orderliness develop in setting up a routine of activity all the way from

basic research to evaluation studies, which have made me very optimistic about the future of this field.

Now, I would like in addition to these off-the-cuff statements, I would like to have my full statement in the record.

Senator BIBLE. It will be so incorporated. You may either read the entire statement or any part that you think is particularly pertinent to our hearing on S. 86.

Senator CASE. I am afraid that my remarks caused Dr. Schaefer to omit part of his statement which I have been handed. I see that starting at about the middle of page 1 he has omitted saying anything about what he has said there and page 2 down to the middle of page 3.

In spite of his modesty which perhaps led him to do that, I think he ought to read that, because I think it would be informative to the committee and to others who may testify and may want to ask questions based on this experience that he relates.

Dr. SCHAEFER. I am very sorry. I realize you have a large agenda, I was hoping to cut corners and let the committee read it for themselves. On the other hand, I would be happy to do it for the record if that is indicated.

Senator BIBLE. It might very well suggest some worthwhile questions.

Dr. SCHAEFER. Eleven years ago, while working as a research chemist and experimentalist in the field of meteorology as an outgrowth of defense activities conducted during World War II, I discovered the method of seeding clouds with dry ice while studying supercooled clouds in my laboratory. On November 13, 1946, flying in a small airplane over western Massachusetts, I dropped 6 pounds of crushed dry ice into a supercooled cloud and thereby touched off the series of events which brings me before you today. The spectacular change which occurred in the cloud I seeded on that day fired the imagination of many people in this country and abroad and gave rise to many interesting, exciting, and sometimes ridiculous ideas.

Within a short time after my cloud seeding adventure over Greyloch Mountain in Massachusetts, my colleagues in the General Electric Laboratory, Dr. Irving Langmuir and Dr. Bernard Vonnegut, made additional contributions to the important field of experimental meteorology when Langmuir discovered and described methods of modifying clouds by the use of water seeding which develops rain in clouds by the coalescence process and chain reaction and Vonnegut's highly important discovery of the effectiveness of silver iodide seeding from simple generators which could be operated on the ground or carried by airplanes for modifying supercooled clouds. This method is the present basis for most of the commercial seeding activities underway in this country and most other countries of the world.

This field of "rain increasing," "hail suppression," and related activities has not been free of controversy and heated debate. As with any major departure from the current patterns of accepted knowledge, the past 10 years have been characterized by exaggerated claims, fanciful ideas as well as honest differences of interpretation of laboratory and field results.

In 1947, Langmuir, Vonnegut, and I, as representatives of the General Electric Co., joined with a group of Army and Navy technicians and scientists using aircraft furnished by the Air Force and Navy

to form what was called Project Cirrus. This was essentially a Defense Department sponsorship of an exploratory study of the possibilities and limitations of cloud seeding as well as atmospheric studies. Much of the present worldwide interest and progress in this field at the present time stem from these pioneering research studies sponsored by the United States Government.

Project Cirrus was continued for 5 years after which we requested that it be discontinued since our objectives had been achieved.

Since that time, Dr. Langmuir has continued an active interest in large-scale weather effects, Dr. Vonnegut is now engaged in field testing of new ideas concerning tornadoes and thunderstorms, and I have become involved in a rather broad program of exploratory studies concerned with the physics and chemistry of the atmosphere as well as experimental meteorology. My deep interest in the orderly development of experimental meteorology explains my reasons for being here before you.

For more than 5 years I have been urging the more widespread use of the facilities of land-grant colleges and other public and private research organizations toward solving some of the intriguing, fascinating and highly important problems in atmospheric research. I have discussed this formally and informally with farmers, ranchers, businessmen, professors, and research meteorologists throughout the United States but more intensively in the regions west of the Mississippi, from Tucson to Seattle and Topeka to Los Angeles.

I firmly believe that there should be some small group of research-minded people in every State and Territory of the United States who are thoroughly versed in the various aspects of the subject of experimental meteorology and related subjects so that they are in a position to advise and encourage the exploitation of useful knowledge and valid research projects which may benefit their region as well as the country as a whole.

Many unwarranted claims have been advanced which suggest that the time will come when we will have complete mastery of the weather. I personally have a strong feeling that this is not only impossible but, even if it could be achieved, that it would be highly undesirable.

I would rather hope that our efforts, and that of those who follow us in this field, will be directed more toward attempts to moderate or even prevent disastrous weather such as severe hail and thunderstorms, persistent droughts or excessive rains, death-dealing tornadoes and hurricanes and similar phenomena, some of which result from the organized buildup of excessive amounts of latent energy which, when triggered off, cause such things as torrential rain, damaging hail, severe wind or forest fires induced by lightning.

Such effects seem likely to be susceptible to man-induced control by learning to modify such potential storms before they have developed into the large systems which cause disaster. Whether it will ever be possible to avert or alleviate drought or excessive rain situations is a much more difficult problem to evaluate and one which requires much more basic knowledge of the general atmospheric circulation before we will know whether there are weak spots where trigger devices may be employed.

I find myself increasingly optimistic over the future of our attempts to exercise some degree of control over localized weather phenomena.

As with any new science, every forward step uncovers a vast array of new problems, many not anticipated. The solution to some of these always tends to new and sometimes important new discoveries. The approval of the bill we are concerned with in this instance should assist materially in the continuance of the modest but definite achievements we can credit to the Advisory Committee on Weather Control.

This body has contributed immeasurably toward the creation of a real degree of order in this highly controversial subject and it, or some group organized along similar lines, is necessary, in my opinion, if we are to enjoy a continued advance toward maintaining leadership in this important field. The type of cooperative effort which can be initiated and maintained by such a group is not only desirable, but it is essential if we are to continue the progress which is underway.

The terms of the bill we are considering seem to offer a continuance of progress in a field which offers worthwhile achievements of far-reaching importance to the wellbeing of our Nation as well as the world. Such progress can only be built on the knowledge attainable from competent people. This bill offers the hope that we can enlist the aid of new groups as well as the continuance of proper coordinated effort. I hope and trust it will receive favorable consideration.

Senator BIBLE. Doctor, it has been suggested to this committee that this 5-year program is an insufficient period of time in which to come up with a conclusive series of results. Would you care to comment on that?

Dr. SCHAEFER. Well, it is certainly near the minimum. I think that from a statistical standpoint, it is probably not enough, but certainly I am sure that if the aid of the competent people in the field were enlisted, that we would be a long way toward having some answers.

Now it is like any research, you never have all the answers and actually the more answers you get, the less you know, because you are continually coming into contact with the unknown. Therefore, I think that one shouldn't even think of saying that after 5 years we are going to have all the answers.

However, I feel very strongly that after 5 years we will be in a much better position than we are now to see where we go from there. Because, as in any of these new fields, one can't possibly hope to get all the answers to a thing as complex as the weather.

Otherwise, we would have had the answers a long time ago, because there have been many millions of dollars spent on forecasting and all sorts of things and we still have a long way to go. But I think that the amount of money spelled out and the length of time is both modest and reasonable.

I don't think we could spend much more than what is being asked for. But, on the other hand, I think it is extremely important that this be done in an orderly manner. There have been many millions of dollars spent so far in somewhat random projects which have not been interrelated to each other in any way, and when one looks at what has come from such work, one is somewhat appalled to see how little basic data we have gathered.

In this relation I think we can learn a great deal from some of our foreign friends. For example, in Japan, the Rain-Making Committee of Japan includes representatives of all different groups, including the Weather Bureau, the Meteorological Service in Japan, commercial

groups, the universities, all banded together toward a common objective.

We do not have that in this country and I think it is too bad that we don't. Instead of in some cases trying to prove that things don't work, we should be working together to find out why they don't. Because, after all, the atmosphere is something which is like a laboratory experiment, and a chemist, when he works in his laboratory, finds many things that don't work, but he always keeps looking for things that do.

In other words, he doesn't take a negative approach. All I am pleading for is that we in this country do everything we can to take the positive approach toward our problems.

Senator BIBLE. Doctor, may I interrupt? Do you mean that we have various governmental agencies each trying to preempt the field and working at cross purposes on this program?

Dr. SCHAEFER. I wouldn't say quite that, but things are not as good as they could be.

Senator BIBLE. If this act is passed and the authority vested in the Advisory Committee on Weather Control, would that be an orderly approach to the problem?

Dr. SCHAEFER. I would definitely say so. From my standpoint, more or less as an outsider looking in, I have been very much impressed with the gradual orderliness developed in the last few years toward realizing the objectives we all realize have to be met. If we are to throw it out at the present time, I think we are losing 3 or 4 years of experience.

I am not saying that we should have an empire-building setup or anything of that kind, but I think we should build on what we have and not start over again in another direction, which is something that could happen if we are not very careful.

Senator BIBLE. Up to this date what agencies or what governmental agencies or what private institutions have been doing actual work in the field of weather modification?

Dr. SCHAEFER. Well, there have been a great many, of course. There have been the commercial groups, 4 or 5 fairly large ones, there have been quite a number of universities who have had contracts from the National Science Foundation, from some of the private foundations, probably from some State funds, and in some cases from the Advisory Committee on Weather Control, all working toward trying to have the answers to a lot of the problems we have.

Now, I think it would be very bad for any group to set themselves up to be the final answer to it all, but I think we should have some group, at least, which tries to coordinate the work that is going on.

Senator BIBLE. To date, who has been trying to do exactly that?

Dr. SCHAEFER. The Advisory Committee on Weather Control is the only group I know of which has been able to achieve that result.

Senator BIBLE. You believe they have achieved rather satisfactory results in that connection?

Dr. SCHAEFER. I would definitely say so. I realize this is not without controversy. But from the general overall picture, I would say for the first time in the last year or two, one begins to have hope that an orderly process is in the making.

Senator CASE. May I interrupt?

Senator BIBLE. Certainly, Senator.

Senator CASE. Dr. Schaefer, the Advisory Committee, I think, has done well with the power we gave them legislatively. But when we passed the act under which they are formed, there was a feeling that as far as we could go at that time would be merely to require the reporting of results from various agencies, private, and public, that were working in the field and charged the Advisory Committee with the evaluation of those results. But there has not been, so far as I know, any authority with the Advisory Committee or anywhere else to say to this university or that university or this corporation or that corporation you do this, in this particular field, and to another, you stay out of that field and go into another.

The Advisory Committee might have gone further, but all it could do has been to advise. It has not had the authority to direct research as such. It could cooperate with the States, but it does not have the statutory authority to direct research.

Dr. SCHAEFER. I personally think the National Science Foundation is a far better group to handle contract work and things of that kind. But I think there should be a close coordination between that group and the Advisory Committee on Weather Control or somebody like that.

Senator CASE. At that point, if I might, I would like to ask, would you make a distinction between basic research and applied research?

Dr. SCHAEFER. Well, this is a very difficult question to answer, because very often some of the most basic new discoveries are made during applied research. But they are always made by people who have their mind conditioned to accept new things. Sometimes what we call fortunate accidents.

Senator CASE. You have made a very significant statement. I don't want to lose the significance of it for the record or for those present. You said that sometimes some of the most interesting discoveries have been made in applied research, which, Mr. Chairman, may have considerable importance in the final deliberations of the committee. There has been a feeling on the part of some people that the only research that should be authorized by the Government is what we would call basic research. It was my purpose in introducing this bill to go beyond that and to get into the field of applied research because I have felt that some of the things we need to know can never be discovered wholly in the laboratory. We have got to get into the field.

Dr. SCHAEFER. That is right.

Senator CASE. And have some field research or field experimentation, working upon what has been discovered in the laboratories.

Dr. SCHAEFER. We need to develop an entirely new group of meteorologists who are basically field observers. Fifty years ago the meteorologists in the world were good observers. Then for some reason or other, I have never been able to understand,, the art of observing in the field became secondary and a great deal of very excellent work has been done on the desks and from the teletypes and all that sort of thing.

Now we need to reactivate this business of looking at the atmosphere and understanding what goes on there, and the only way to do that is to actually get out in the field. And the only way you can do that is

working with an applied research activity. I don't think that necessarily both groups have to be exactly the same, but we should have a few good research people who are free to move around where these applied things are going on, become completely familiar with it, alert the local people as to the various things to look for, and then as time goes on we will, I am sure, learn all kinds of new things.

Senator BIBLE. What you are saying is they both should go on.

Dr. SCHAEFER. Exactly.

Senator CASE. That is the whole point, Mr. Chairman.

Senator BIBLE. I know we have had comments that there hasn't been adequate research and this bill was probably premature because you had not completed the basic research.

Dr. SCHAEFER. You will always find that in the successful research laboratories a good director sees to it that the fellow who is concerned about applied research is also working closely with theoretical physicists, and chemists. And when you see the results of such coordinated work, you always see a successful laboratory because you can't possibly do all the things, figure out all the things before hand.

One nowadays hears a great deal about planning and the ability to plan for new ideas. This is ridiculous. I once asked Dr. Langmuir how many of his basic discoveries came by sitting down and working things through to its ultimate conclusion. He said not one, everyone of them was a fortunate accident. But his mind was receptive to this accident, and therefore when he saw it happen he exploited it. That is the kind of thing you find when you work in the field. You can't possibly get the answers in a laboratory. You have to go out into the field.

Senator CASE. But he worked in the laboratory enough that he was able to recognize something when it happened in the field?

Dr. SCHAEFER. That is right.

Senator BIBLE. I appreciate that contribution, Dr. Schaefer. At our first hearing on this bill we had some testimony about the use of weather modification in fogbound airports.

Do you have any comments on the advances that have been made in that field? Is that at all realistic as yet?

Dr. SCHAEFER. Well, there you have to differentiate between supercooled clouds and warm clouds, or warm fog and supercooled fog. I think in the case of supercooled fog there is a very good chance that one can remove or at least modify to a useful degree low-lying stratus and the fog which is on the ground.

Now, it is much more difficult in terms of the warm cloud because in the warm cloud, the particles are very far apart; it is hard to get them to coalesce, because they don't have much substance, and, while I certainly am not dismayed at the possibilities, I would say that we don't know any very effective way at the present time.

Senator BIBLE. Who does research in that field? Is that an airport program, airlines program?

Dr. SCHAEFER. Some years ago a great deal of work was done at Arcadia, Calif. It was a cooperative approach in which a number of governmental agencies as well as private concerns, who thought they had the answer to fog-removing methods, pooled their resources and attempted to remove the fog, and I might say quite unsuccessfully. It is not an easy problem.

But like any of these things, maybe the answer to it lies just around the corner and the person with the right idea hasn't yet come up with it. Maybe something in the field of electrical phenomena is the answer.

Senator BIBLE. Senator Schoeppel, do you have any questions?

Senator SCHOEPPEL. I will defer to Senator Case.

Senator BIBLE. Senator Case you may question Dr. Schaefer.

Senator CASE. Your question, Mr. Chairman, brought to my mind this brochure entitled "Project Cirrus, the Story of Cloud Seeding," which was reprinted from the G. E. Review for November 1952, on page 18 of that brochure there are a couple of photographs which show the paths in clouds which were cut by seeding with dry ice.

Dr. SCHAEFER. I think this is the field of meteorology in which you will find very little argument about the result of these effects. Everybody has agreed that, with the proper degree of supercooling, there is no difficulty whatever in cutting holes in clouds; we have cut holes and descended through them in actual flight operation. This is one field I am pretty sure there is very little controversy in any more. But I should say when it was first proposed we were greeted with a great deal of skepticism.

Senator BIBLE. May I ask a question so that I can understand this just a little better?

Have you actually gone into a fogbound airport and made any type of weather modification which lifted the fog enabling the airplanes to land?

Dr. SCHAEFER. We have done it not with the fogbound airport, but with an airport which had a layer of low stratus clouds above it, a few thousand feet above, which was closed to any planes which were not equipped for instrument flying.

Senator BIBLE. Except instrument flying, only those could come in?

Dr. SCHAEFER. That is right. A hole was produced so that a plane not equipped for instrument flying could go down through and land. This was done.

Senator BIBLE. I see.

Dr. SCHAEFER. This kind of thing has been developed to a rather good degree by the United States Army Signal Corps in some more recent experiments.

Senator BIBLE. Senator Schoeppel has a question.

Senator SCHOEPPEL. Dr. Schaefer, what other nations in the world have moved out, in your judgment, in a very practical way on this overall study that you are discussing?

Dr. SCHAEFER. Well, this is not too easy to answer, Senator, because things are changing so fast, but I will say this, that the Japanese have done a very outstanding job as far as I have been able to determine in talking with the people in the field. They have so far as I am aware the best coordinated program at the present time.

The Swiss have a Federal commission on the study of hailstorms which is directed primarily toward the possibility of suppressing hail.

In most of the countries there are programs under way, some of them well coordinated, some of them the same as in this country.

There might be somebody in the audience who could answer this a little better than I could. But I would say in a general way I don't know of any country which doesn't have something going on in the field.

Senator SCHOEPPEL. In other words, the other countries of the world are on the move in this general area of exploration?

Dr. SCHAEFER. That is correct.

Senator SCHOEPPEL. Let us now discuss the situation in our own country. It seems to me as though there is lacking an agency to bring together all this information for evaluation.

Dr. SCHAEFER. That is right.

Senator SCHOEPPEL. Now, here we have our Government weather agencies. There have been some who have discussed this matter with me since I am a member of this subcommittee who have said, "Well, why should we have any other approach than the strict or the centralized approach to the weather activities of all types and kinds centered in one central Government agency, for the most beneficial results, for the most economical approach, and better able to control all of it?"

Now, I take it from what you have testified here this morning that you believe that under this bill there rests a framework for doing just that. Is that a fair statement of what you feel?

Dr. SCHAEFER. Well, I would personally very much deplore any organization which would completely funnel all of it through any one agency. After all, this is still a democracy, I hope, and therefore I think it is extremely important that we retain the initiative of individual groups to carry on their own research. But I would hope that we would have some centralized agency which would be continuously reviewing what is going on and encouraging work done where gaps appear. I think it would be very dangerous to put all this control in one place.

Senator SCHOEPPEL. That is the very point I want to make here, that is the very point I want to bring out.

Dr. SCHAEFER. There is no group that is ever going to do the same as any other group. Therefore, if two groups went out to carry out a fog-prevention program, let's say, one group would approach it in an entirely different way than the other group, therefore you are sure to get something more out of this double approach than if one group carried all the work on its own shoulders. Therefore, I think anything which develops in this field should have the freedom of action that we enjoy in this country as typified by the private groups, the public groups, and—by "public groups" I mean the State-sponsored groups, as well as the Federal groups—and I think it is highly desirable that all we have is a group that keeps an eye on what is going on and periodically revises and brings together in conferences the workers in the different fields, but at the present time we have no effort of that kind except the Advisory Committee on Weather Control. They have sponsored several conferences in which we do have a chance to get together and swap ideas. But I think it is quite desirable that they be given a greater hand than they have had in helping where they see deficiencies, either helping by actually having the ability to let projects or by drawing the attention of the National Science Foundation to the need for work being done in certain fields.

Senator SCHOEPPEL. Then from a legislative matter it would be your judgment that we should leave that in a very, very flexible way for the greatest possible experimentation and approach in the various—say the areas of the country, as well as your individual private groups, scientific groups? In other words, we had better watch this thing of control or rigidity very carefully.

Dr. SCHAEFER. That is right. Of course, when you do that you immediately say, "Well, this is therefore going to be pretty expensive." But I think in terms of the value to be obtained it is not at all expensive.

We retain the thing which has made our country what it is, the initiative of the private individual to go out and find things out for himself and not having somebody tell him what to find.

Coordination is the primary job that I would think this central group should have.

Senator SCHOEPPEL. In other words, then, that should be encouraged as much on a voluntary basis rather than on a mandatory approach.

Dr. SCHAEFER. Of course, that is one of the nice things about this bill: it says you put up matching funds, and we will work with you. I think that is quite important, because you have to have interest and enthusiasm and a desire to do, if you are going to get anywhere in the field, because it is a very difficult one.

Senator BIBLE. Dr. Schaefer, if I wanted to find out today exactly what had been done in this field of cloud modification from all of the different agencies, private agencies, Federal agencies, land-grant colleges, any others that might be interested in the work, where would I go?

Mr. SCHAEFER. If you ask me that question on the telephone, I would say call Capt. Frederic A. Barry in the Advisory Committee on Weather Control. He probably knows more about what is going on than anybody else. At least I would hope this would be the case, and it ought to be.

Senator BIBLE. In other words, they gather the results of all these various weather modification programs?

Dr. SCHAEFER. That is right. And in my contact in the field that is the group that is now being recognized as the group that gathers this information together. It is the logical way to have this happen. After all it is almost the ideal situation in that you have both private individuals as members and Government representatives as individuals. They don't all see eye to eye, which is very good. Therefore, it is the interplay of the various minds represented in that group which makes it as effective as it is.

Senator BIBLE. You think in that connection S. 86 does not become too restrictive?

Dr. SCHAEFER. That is right; I think it is ideal the way it is set up, just as it is.

Senator BIBLE. Pardon my interruption, Senator Schoeppel.

Senator SCHOEPPEL. I have no further questions.

Senator BIBLE. Senator Yarborough desires to question Dr. Schaefer.

Senator YARBOROUGH. Dr. Schaefer, I note from page 4 of your statement that you say that control of tornadoes or lightning, and the effects are likely to be susceptible to man-induced control. I judge as a scientist by using the word "likely" there you mean that you think it within the realm of feasibility that we are able to do something about these death-dealing tornadoes; is that correct?

Dr. SCHAEFER. The only way I can see, the only hope I can see of approaching that very important field is to make a basic study of where these storms come from. Now, fortunately the United States Weather Bureau, through the severe local storm warning center in

Kansas City, is doing an exceptional job, in understanding what goes on. I have a feeling within the next few years we are going to have the answers to a lot of questions that are plaguing us now. First of all, where do they come from, how fast do they come, where do they form, is there any possibility that before they become a death-dealing storm that they are moderate storms or even minor storms which somehow become coordinated?

If that is the case, there is a possibility that by seeding the young storms before this potential energy builds up, one could dissipate them. That is the philosophy that we follow with both lightning and hail. You mentioned that you would like to have mention made of that.

The only way I can see where one can ever hope to modify severe storms of that kind is to catch them before they are severe, when they are still just puffy clouds over a mountain or when they are just a small mass of clouds moving across the plains, and somehow learn to dissipate them before they become organized. Now, this is not an easy job and I doubt if in 5 years you are going to have the answer to it. But we are never going to have it unless we start toward it. As I say, I would like to pay tribute to the group at Kansas City who are doing this exceptional job in understanding more of the basic causes, developments which produce the tornado.

Senator YARBOROUGH. I have no further questions.

Senator BIBLE. Further questions, Senator Case?

Senator CASE. Dr. Schaefer, do you think that any private agency will dare undertake modifying with these potentially dangerous clouds?

Dr. SCHAEFER. No; I don't.

Senator CASE. The reason I asked that, Mr. Chairman, is that in the history of Project Cirrus, which was compiled by the public relations services division of General Electric in July 1952, they relate that flight tests of December 20 produced or seemed to produce a general snowstorm or at least there was a coincidence of a snowstorm, and the fact caused some independent speculation and it was so important that it was brought to Dr. C. G. Suits, director of the Research Laboratory of General Electric, brought by him to the attention of Vice President R. E. Leubbe, who was general counsel of the company.

> It was recognized that the possibility of liability for damage from cloud-seeding experiments was a very worrisome hazard in this new form of cloud experimentation. Since such a threat to the share owners' money would not be balanced by any known gain to the company's products or business, there was great reluctance to incur risks of uncertain but potentially great magnitude.
>
> It was considered particularly important for this reason that any seeding experiments be conducted under Government sponsorship. No further seeding flights were made until such sponsorship was provided.

I have read that from this report by General Electric, and then, however, a contract was received from the Signal Corps which led to the project which became Project Cirrus.

The reason I am asking that question is because with this interest that there is in the modification of clouds before they build up—and its significance, perhaps, for control of hail or at least modification of hail and lightning and even perhaps tornadoes—if we are to have any research in that field, I feel that the Government is going to provide it, that the commercial cloud seeding companies will not monkey,

so to speak, with the rough cumulus clouds, if they think there is any danger of any damage coming out of them.

So we are going to have to have some projects which will be designed to fill these gaps of knowledge, and Dr. Schaefer, I think, very significantly used the word "gaps" a few minutes ago. That is why in the bill we sought to make it possible for contracts to be given to the Government agencies such as the National Science Foundation, or Weather Bureau, or the Department of Agriculture, the Department of Interior, or land-grant colleges or universities where they could proceed with the knowledge that the Government was the sponsor of the project and hence perhaps take some risks that a private company wouldn't take.

Dr. SCHAEFER. Of course, along this line I think perhaps I should point out that this was one of the bugaboos of all commercial activities in the early days. Nowadays, so far as I know, the commercial operators don't worry about damage suits and things of that kind. But the reason why they don't worry about it is because they realize that they would find plenty of meteorologists who would agree that they had no effect whatsoever on what happened.

Now, this is likely to change——

Senator BIBLE. Even though it did happen.

Dr. SCHAEFER. Even though it did happen. Because they would say, "Well, nature has produced it." I don't know who would prove that they were wrong. But the time is going to come, if we make progress in this field, when this will no longer be the case, then people more and more will have to take responsibility for it, provided, of course, these things are successful. So I think it is very important that the Government does not lose contact with what is going on, because after all, it is basically something that the Government has every right to participate in, and a real duty.

Senator CASE. In the interim report of the Advisory Committee to the Congress they made some fairly definite statements as to the results which had been obtained on the west coast and in cloud seeding in mountainous areas. They did make a statement something to this effect, however, that it was uncertain as to whether or not those results or those methods could be extrapolated to the plains areas, which I have felt was one of the gaps, but I have also thought that perhaps the gap was in the type of method and the type of cloud with which you would deal in the two different areas. The cloud modification companies and corporations which have worked on the stratus, the low-stratus clouds, use the ground generators, but not so many of them have been either willing or active in working on the rougher, high cumulus clouds.

In that I felt there was a gap in the development of knowledge. I would like to have your comment on that.

Dr. SCHAEFER. I definitely think this is the case.

One of the things I did not mention is that some extremely important work is going on in Australia. In Australia they have probably done more on a large scale than any other place in the world, in that they are using jet airplanes for seeding over large areas which are essentially inaccessible by any other means. Now I think in that respect they have hit upon the only way you are going to have a quick answer to the plains problem. One of the real problems in

trying to understand what happens in storms in the plains is that you never know whether the silver iodide going off from ground generators ever reaches the target region. One way of overcoming this, of course, is to put the seeding material right in the clouds by airplane, flying at the base of the clouds or above the clouds or in them.

That kind of thing has to be done before you are going to have a definitive answer in the plains regions, because you don't have the mountains to force the materials into the clouds, such as they do on the west coast.

Senator CASE. Mr. Chairman, you may recall that at our earlier hearing I called attention to the experiment which we conducted in South Dakota last year, that there was some feeling that where we lacked these low stratus clouds and we didn't have the high humidity, but we did have these high drifting cumulus clouds, that the only way we knew to reach them was to use jet aircraft. And with the advice of the Advisory Committee we had a project there where we used jet aircraft. I think on the first experiment they went up with a C–47, but they just couldn't get up fast enough to get into the cloud before it would dissipate. But by using jet aircraft we could attack clouds that were 12,000 feet, and they found that when seeded they rapidly built up to about eighteen to nineteen or twenty thousand feet, but with the jet aircraft they were able to stay with them until they got the seeding accomplished. And I think, also, Senator Yarborough, that that is the field in which we will find some answers to the questions you raised about the possible modification of clouds that have tornado or hail potentials.

Senator BIBLE. Thank you.

Senator YARBOROUGH. Just one more question.

Senator BIBLE. Certainly.

Senator YARBOROUGH. Dr. Schaefer, we had in Texas in the space of approximately 1 week, 38 tornadoes, actually viewed and charted and recorded, and 800 homes destroyed in Dallas in a few minutes on the afternoon of April 2, 1957. In the course of about 1 month we had property damage in that 1 State alone of over $100 million from tornadoes and the accompanying cloudbursts and other phenomena that went along with the tornadoes. In view of the record of that loss in 1 State alone in 1 month's time from the extraordinary weather conditions or phenomena, would you say that the $5 million that Senate bill 86 carries with it is a modest appropriation, and necessary, for the work to be done?

Dr. SCHAEFER. I would say it is very modest. I am sure that you could use more money than that at the present time. But my hope is, that as times goes on and we find more people available in the field, that we can get more. But money is not the important thing in this field, it is people, and the right kind of people, and there aren't too many of them around as you all know.

So the only way we can possibly hope to get an answer to this kind of problem is to make it feasible for those good people we do have to be able to do the things they need to do and are willing to do.

At the present time, some of our best people just have none of the facilities, you might say, to do everything that they are capable of

doing. And I think this could very easily fill the gap that we now have at the present time.

Senator YARBOROUGH. And do you think this law might furnish the incentive for them to put forth their best effort?

Dr. SCHAEFER. If you have something which is a 5-year program, or on that order, you can plan. The one big trouble, I think, in most efforts sponsored by the Government, is the fact that you start a program and it is subject to yearly review, that is yearly appropriations. You can't do basic work this way, or even applied work. You just get well underway and suddenly the money is cut off and most of your work has been wasted.

I think it is high time that our Government recognized the fact that most basic work is long range in its objectives, and that, somehow or other, some procedure is established whereby this is recognized, and that sufficient money is granted on a long-term basis.

Now, if you select the right people at the beginning, you are not going to be worried about people getting into a job just because it is a job. This again comes right back to the individual, and, if you get the right kind of individuals, then it is my opinion, which can be backed up by all kinds of industrial research organizations, that the way to get effective results is to not have them worry about where their next project money is coming from. Now, this requires some careful administration, administration which succeeds because the direction isn't obvious. I am not sure I am making myself clear. But a successful director of a long-range research project sees to it that the research individual or group of individuals who are working on a project are not worried about whether they are going to have a job next year.

Senator YARBOROUGH. You speak of the kind of direction, I take it, that is inherent in any successful long-range scientific program.

Dr. SCHAEFER. That is correct.

Senator BIBLE. Thank you, Dr. Schaefer. I want to compliment you on your very fine statement. The Chair is a little curious about the name of your foundation. Does it have any particular significance; Munitalp.

Dr. SCHEAFER. It is the word "platinum" spelled backward.

Senator BIBLE. Is there any particular significance to that? I had trouble in pronouncing it originally.

Dr. SCHAEFER. It is a very amusing story. The organizer of our foundation was Albert W. Johnston, a mining engineer of Greenwich, Conn., who was very modest and didn't care to have his name tied to the foundation, so one of his trustees suggested that he use the cable address of the company, and Munitalp is the cable address of the company. That is all there is to it. [Laughter.] Dr. Langmuir's report on "Widespread Control of Weather by Silver Iodide Seeding," is on file with the Committee.

Senator BIBLE. I was puzzled. I am sorry I stumbled over it originally. If it had been platinum, I wouldn't have stumbled over it.

We have with us the senior Senator from Utah.

Senator Watkins, I know of your interest in this legislation. We are very happy to have you here at this time.

STATEMENT OF HON. ARTHUR V. WATKINS, SENATOR FROM THE STATE OF UTAH

Senator WATKINS. Thank you, Mr. Chairman. I have been very much interested in the investigation that has been going on. I had staff men do a little research. I think it might be interesting to the committee to know some of the background of long-time-ago experiments made in rainmaking. You may have had all this before, I don't know. I am not acquainted with the record up to this point.

Senator BIBLE. We attributed the original bill to the Indians at the first hearing, Senator, but we didn't go into it.

Senator WATKINS. The rainmaking, or bringing rain from the clouds in a season of drought, has been of the greatest interest to mankind in all ages. Droughts and the famines that, historically, have often been their aftermath, have led to prayers to the Almighty in Christian countries and to human sacrifices in pagan lands, in quest of beneficial rain.

Here in America the question of bringing about rain by scientific processes has held attention for more than a century. Nothing—that rain seemingly followed forest fires—a Pennsylvanian, James P. Espey, in 1834, proposed, as a rainmaking device, building enormous fires. Similar suggestions were made in Australia.

Since this seemed, to many, a case of cure being worse than disease, the idea was dropped as impractical. Espey it was, however, who in 1841—at about the time that the laws of thermodynamics were being formulated—shows that ascending air expands and cools its vapor to the point of saturation, thus causing rainfall. Also Espey showed that descending air is warmed by compression, and clouds are thus dissipated, and that the daily heating of the lower strata of the atmosphere causes convectional currents and the formulation of cumulus clouds.

It was, however, another theory—other than igniting enormous fires—that led to the first action by Congress in rainmaking research. This was the theory that cannonading, as that of heavy artillery, might disturb the atmosphere sufficiently to cause rain. In 1891, Congress thus appropriated a sum to support experiments conducted in Texas by General Dyrenforth, for the Department of Agriculture. Giant powder explosions were credited by the general with provoking precipitation, but Dr. W. K. Curtis, who was with the Dyrenforth party, negated this conclusion, and in this opinion was supported by a similar finding by Prof. A. H. Hazen. For more than a score of years thereafter the theory that rain frequently followed aerial explosions was debated in desultory fashion, and in that period no really serious efforts were made to follow up the Dyrenforth experiments.

I think here, too, we should be mindful that, although Federal sponsorship of weather reports began with congressional passage of a resolution February 9, 1870, it was not until July 1891, when Congress transferred this function to the Department of Agriculture, that our present Weather Bureau took on its greatly enlarged scope of meteorological activities.

One needs to consider only for a moment the major scientific advances of the present century to realize that tremendous strides forward in our meteorological knowledge have occurred. For example, the accuracy and the scope of our forecasting knowledge.

Little more than a century ago this entire science was largely theory; now it is daily and common practice. Thus, we may consider that—in many things scientific—yesterday's dreams have truly become today's realities, where research and study have been allowed free hand and support.

This minor introduction, then, serves to call attention to the bill, S. 86, of which I speak here; it is a very modest approach to a challenging research program which truly has potentialities of tremendous long-range significance for all sections of the country.

When we consider the tremendous extent within so many of our States that are afflicted with subnormal rainfall, we can appreciate that droughtwise this is a major problem.

There are corollary considerations, as well. Drought alone is not the problem. For instance, lightning storms cause tremendous damage to the timber resources of the country. Also, hailstorms cause additional millions of dollars of damage. Now it is important that we appreciate that research in cloud modification is concerned, not alone with drought problems, but those having to do as well with such matters as these—lightning and hailstorms. Now, certainly, positive and scientific efforts in these three directions are eminently worth encouraging.

Now, again, in encouraging a 5-year research program such as this measure, S. 86, proposes, we are advancing a most economical sum; if the results are even as much as partially successful the gains we thus make may be literally astronomical in their proportions.

I know we are all seeking economy in Government, together with the provision of service for our people. Well, then, consider this:

During just the last 3 years in but 1 part of the country—the Southwest largely—the Federal Government alone has spent some $550 million for disaster relief, due to drought, and an additional $184 million to bolster livestock prices. Think of that; more than three-quarters of a billion in 36 months. That means, Federal costs for this drought relief have been expended at the rate of nearly $24 million a month. Now bear in mind that the States involved, themselves, have spent many more millions, and I would conservatively estimate that the losses to individuals living in the drought area have in this same 3-year period actually risen to billions of dollars.

Senator BIBLE. Would you pardon an interruption at that point? I find my commitments are such that I must leave a few minutes before 12 o'clock. It was my intent to recess at about 10 or 15 minutes after 12 until 2 this afternoon. With your permission at this time, I am going to turn this over to Senator Yarborough. I will read everything very carefully that you say in this record. I must leave for this prior commitment now.

Senator WATKINS. Thank you, sir.

Senator BIBLE. We certainly want to welcome you to come back at 2 o'clock if you like.

Senator WATKINS. I have other commitments. I sat in a number of hearings with the Interior Committee that were very, very interesting. I am glad this committee is taking it up.

Now, bear in mind, also, that this expenditure does absolutely nothing to mitigate the original cause of complaint—the drought itself.

That is where S. 86 may allow for economy, if ways can be found

to divest us of at least a part of such prolonged drought. S. 86 calls for a comparatively modest investment, a maximum of $1 million a year for 5 years.

In my judgment, this is a warranted and sound investment in research in a field where the need is being so tragically demonstrated.

If in 36 months we can afford to spend more than $734 million for a purely stopgap type of drought-relief aid, surely then we can afford to hazard $3 million in similar time to effect some positive benefit.

There are other positive points in presently considering the economy and relatively simple hazard in this proposed Federal research program. As you are doubtless aware, State, organizational, and private interests have been pursuing this topic of cloud-modification research. I should like at this time to underline the fact that the American Meteorological Society, through the office of its executive secretary in Moston, Mass., released the latest of its three successive evaluations on the scientific aspects of weather modifications and control on April 30 last.

The society, composed of nearly 6,500 members, is the professional and scientific organization which represents weathermen throughout the Americas. Its member-meteorologists serve private industry, universities, and colleges, and the Government weather services.

For brevity, I shall here refer only to portions of that statement which brings up-to-date information originally summarized in 1951 and 1953. Here are but some conclusions the meteorologists make:

1. Evaluation performed by independent agencies have yielded reasonably convincing evidence of increases of precipitation due to the operation of ground-based silver-iodide generators only for operations conducted in cold weather in regions where forced lifting of the air over a mountain range is an important factor. * * *

2. In the absence of a truly quantitative theory of precipitation, the best present means for obtaining a quantitative estimate of the effect of seeding on precipitation is through the statistical evaluation of randomized cloud-seeding experiments. * * *

3. All cloud-seeding operations should be considered as experiments, since the techniques are still under development and there is no sound basis for the quantitative estimation of the results in advance of the operation. As experiments they should be designed primarily to yield optimum scientific results. There is good reason to believe that improved returns from cloud seeding will result from a sound experimental approach, and this should be fostered by all concerned.

Now I think we should carefully observe the last conclusion, attested to by the officials of the American Meteorological Society, men in a proper position best to know the technical feasibility of this proposed research.

I now wish briefly to turn attention to a report from the Department of the Interior on S. 86, dated April 29, 1957, addressed to the committee's chairman. In part it remarks:

We recommend the enactment of this bill, provided it is amended to conform with the expression of views contained in this report. * * *

Since the general problem of water supply, involving as it does multi-State river basins and drainage areas, is properly considered as being a problem of national interests and significance, we believe it would be appropriate for the Federal Government to undertake a broad research program in weather modification.

Research of this kind is a long-term program and is a definite action plan * * * we recommend * * * that basic research be placed in some agency, such as the National Science Foundation, which is devoted to administering scientific re-

search programs and which has had substantial experience in working with educational institutions and other public and private research organizations. Widespread experimental and productive cloud seeding should perhaps be handled by the Weather Bureau or the Department of Agriculture.

So, the Department of the Interior is prepared to endorse such a type of program, with amendments.

In a letter to the committee chairman, dated May 2, 1957, the Department of Agriculture was of the opinion that the broad research program planning can be accomplished by the Advisory Committee on Weather Control, and this without additional authority and without extending its authorized life.

These are opinions of Federal Government agencies. I am certain that State, organizational, and private interests will welcome Federal sponsorship of a cloud-modification research program, to which their best efforts may therewith be synchronized. I have positive evidence, for example, that in my native State of Utah such would be welcome; in a letter to me, dated last March 22, the director of the Utah State Water and Power Board, Jay R. Bingham, commented:

At the suggestion of the Utah Water and Power Board I am writing to inform you that local interests in Beaver, Sevier, and Millard Counties are interested in a cloud-seeding project, and would like to suggest that legislation now before Congress, sponsored by you, be modified if necessary to permit organizations locally to cooperate with the Federal Government in cloud-seeding projects with or without the participation of the State.

Now, S. 86 will give focus and cohesion to all these State and local projects, the net summation of which experimentation will be beneficial to all interests concerned in increased proportion. In many parts of the Nation—and Utah is but one example—much work is already underway.

May I call attention at this point to Dr. Hale at the University of Utah. He has a private laboratory. He is doing some work at the university, itself, but he is also doing some work in his private capacity. He is a brilliant young scientist, deeply interested in this work. I had a conversation with him not long ago. But he is not in a financial condition to carry on the work that he would really like to do. He has a sincere belief that we can accomplish much through this type of approach.

Now a man of that kind—and there are many of them throughout the United States, I am sure, that are interested, maybe not all as well trained as some others. But they would be very glad to work if we could give them some financial encouragement so they could go on with their experiments.

The Federal program will provide for a measure of control and evaluation of such projects through the most eminent scientific means, further bringing economy and efficiency to our mutual efforts.

For example, in Utah, livestock growers in a dozen counties lying within the southwestern drought area already have formed a Water Resources Development Corp. for experimental research in cloud seeding. As a result, for several seasons large-scale experiments have been effected, solely financed by local tax receipts and contributions in these dozen counties, and many contributions from the livestock growers and farmers down in that area as well.

This type of program, local in nature, gains value when evaluation is encouraged by the objectivity and general accessibility that would be provided in such a measure as S. 86.

Furthermore, the stockmen and county officials involved in such research concluded that, while personally convinced of value of such programs locally, it may be years before their modest project provides sufficient data to properly evaluate economic results. Thus, the program has been somewhat reduced in certain sections. However, it is my belief that the inspiration of a Federal cooperative program will discourage such a trend and revive some flagging interests.

Partially for this reason, I think the committee should hold fast to the cost-sharing aspects that figure in S. 86. I know some would have the Federal Government finance the whole program. May I point out, however, that this proposal reserves three-fourths of the rather modest appropriation for cooperative programs, matched 50–50 by the States and by the local organizations.

Now, it is true this places a rather large burden on the non-Federal participants, but I think it is necessary and thoroughly advisable, for it provides an immediate check against any unwise and unnecessary Federal spending.

Under this proposal, if the need is not recognized and supported by the people in the area affected, then these expenditures will not be made. In my opinion this constitutes an effective brake on Federal spending. Also, it insures a healthy active participation in the planning at all levels by local and State groups.

Now I know certain amendments to S. 86 have been suggested. In my own judgment, I believe that the committee should consider improvement in language in sections 2 and 3. Section 2 provides that the cooperative research shall be carried out by State agencies, including land-grant colleges or other State agencies to be designated by the Governor of the State. I feel that should be amended to include local governments and tax-supported nonprofit corporations with or without participation by the State. If this is done, the matching authority in section 3 should be extended to include such organizations.

I suggest this because, in my own State of Utah, for example, the cloud-seeding work has been carried out not by the State, but by a multicounty public corporation supported by tax revenues from the counties involved.

I have another thought, too, for the States required to match the Federal funds. This would then require special legislation in many States, and, as in Utah, the legislature meets biennially and would not again be in session until sometime in 1959.

In summary, then, I believe the time is ripe for a Federal research program on cloud modification, to aid us in our battle against such terrific toll takers as drought, hail, and lightning has proven always to be.

This proposal, S. 86, allows us, as it were, to put our collective heads together at the Federal, State, and local levels and coordinate all of our efforts to combat these enemies.

And when we consider that on a relatively negative portion of our aid to the drought-ridden we are committing our Federal Government to expend nearly $24 million monthly alone, then surely it is the measure of economy itself to see if— at a cost of but $83,333 monthly—we cannot do something concrete, positive, to rid ourselves, at least in part, of this national problem.

Mr. Chairman, I wish to thank you and all members of the subcommittee for this opportunity to appear before you in support of S. 86.

Senator YARBOROUGH. Thank you, Senator Watkins, for that statement. Senator Schoeppel, do you have any questions?

Senator SCHOEPPEL. Senator, where you made reference to the cloud seeding there, I notice that is prevalent in a number of the States. Since we have this measure before us, naturally the procedure has always been, the committee procedure, to find and get the views of the departments with reference to the type of legislation, get their suggstions on it.

I do not want to be premature, but I assume that the letter directed by the Commerce Department to the chairman of this committee has been made a matter of record or will be. I was interested, however, in the two phases of it, going to cloud seeding now. I am quoting from the letter sent here by the acting Secretary of Commerce to the chairman of this full committee.

> The Department believes it would be unsound to undertake further exploitation of arid-region rainmaking before adequate methods have been developed. This history of the many hit-or-miss seedings undertaken during the past 5 years bears out the conclusion that a program based on a number of uncoordinated experiments will tend to delay rather than promote progress in rainmaking techniques.

Now, I am inclined to believe it has much substance as we look at just the rainmaking technique of it alone. He says:

> In view of the foregoing, it is our conviction that a more expeditious and economical approach to the development of weather-modification techniques would be to center responsibility for the planning and coordination of an adequate program in the National Science Foundation and to authorize that agency to make arrangements for research activities by those private and public institutions that are in a position to make the best use of scientific personnel and facilities available. We are convinced this solution to the problem would result in the required comprehensive program at reasonable cost and would foster cooperation with private organizations and the States in the development of this important meteorological phenomena.

In general, do you agree?

Senator WATKINS. Yes; I think that is what I suggested in my statement.

Senator SCHOEPPEL. I rather gathered that as I listened to your statement, that I could see very little if any variance with the position taken by the Department on this matter.

Senator WATKINS. I substantially agree with the Department. I think more emphasis—of course, this must necessarily be true—more emphasis should be placed on the methods before you get into doing this work.

Senator SCHOEPPEL. What would you say—and we are exploring this matter, and this subcommittee, making its report to the full committee, wants to be constructive obviously in the evaluation of all matters—I note that the Department then goes further and points out one thing to this committee; namely, that:

> The Department believes that sufficient authorization to carry out this program already exists in present legislation governing the activities of the National Science Foundation and other cooperating Federal agencies having an interest in this matter.

I don't want to put anybody on the spot, but I would be appreciative of your views. Do you have any feeling on that?

Senator WATKINS. I haven't examined the law authorizing the Foundation, to determine whether or not that is accurate, but I assume

that it is. They must have checked that rather carefully before they made that report.

Senator SCHOEPPEL. That will be one of the things, I will say to Senator Case as well, who is a sponsor of this legislation here——

Senator CASE. Senator Watkins is cosponsor.

Senator SCHOEPPEL. I know; and you as a cosponsor.

Senator WATKINS. However, the expert is Senator Case. I am just one of those fellows who tag along.

Senator CASE. He is a very able tagger, whatever term he wants to use.

Senator SCHOEPPEL. We have two of our colleagues here who have given study to this. But this is going to be one of the phases of the legislation that obviously will be thrashed out in the executive sessions of this committee, and it might be helpful if we could have some of your views expressed later on in this matter.

Senator WATKINS. I think the National Science Foundation would properly be a proper agency maybe to carry out one type of the work at least; some of the activities. I feel that we should take advantage of whatever experience that Foundation has had in this field and its organization. I don't think we should have a lot of duplications.

That would be wasteful of money. If the existing organizations are in a position to carry out this work, and do it well, I think it would be in the interest of economy to have them do it, and probably in the interest of getting results.

Senator SCHOEPPEL. I felt it might be helpful to draw this view to your attention here. I naturally know that you have followed this matter, and Senator Case has, because that is the view that is going to be expressed on this record.

Senator YARBOROUGH. Further questions?

Senator SCHOEPPEL. I have no further questions.

Senator YARBOROUGH. Senator Case?

Senator CASE. I might say first of all, I want to thank Senator Watkins for his very able statement and for the research that went into it. With respect to this matter which Senator Schoeppel has just brought up, I think we need to keep clearly in mind that there is a sort of dual problem here, and that is the basic research and the field research. We brought out when we were talking to Dr. Schaefer that not all of your questions are answered simply by confining yourself to the the laboratory. As he pointed out, Dr. Langmuir found that that many of his discoveries actually came by trying the thing out, but by having worked in the laboratory enough he was able to recognize the thing when he saw it in the field.

I believe, also, that the statement from the Department of Commerce is going to be supplemented somewhat by testimony by Dr. Reichelderfer, whom you have on the agenda.

I am hopeful that when Dr. Reichelderfer speaks, he will perhaps supplement this statement and shed some light on this problem of whether or not the program should be administered by the Advisory Committee, working through the other Government agencies, private corporations, or whether perhaps there should be some division of responsibility with the National Science Foundation dealing with basic research, and the other agencies, like the Weather Bureau, Department of Agriculture, Department of Interior, doing some direct field research.

Senator YARBOROUGH. Dr. Reichelderfer will be the next witness.

Senator CASE. Mr. Chairman, Senator Watkins referred to a statement that was put out by the American Meteorological Society. It is a very significant statement. He did well to emphasize certain parts of it.

Senator WATKINS. Yes.

Senator CASE. Since it is only about 2 or 3 pages, I wonder if it might not be put in the record for reference.

Senator YARBOROUGH. Without objection, it will be put in.

Senator WATKINS. I would like to have it as a part of my testimony.

Senator YARBOROUGH. It will be added to Senator Watkins' testimony, and it will be part of the record.

Senator CASE. Here is a copy of it.

(The document above referred to is as follows:)

AMERICAN METEOROLOGICAL SOCIETY, OFFICE OF THE EXECUTIVE SECRETARY, BOSTON. MASS.

Dr. Robert D. Fletcher, president of the American Meteorological Society, today released a statement on weather modification which outlines the general opinion of the field of meteorology on this matter of great public interest. The society, composed of nearly 6,500 members, is the professional and scientific organization which represents weathermen throughout the Americas. Its membership is made up of meteorologists from private industry, the universities, and the Government weather services.

The society has adopted a policy of issuing statements, to be reviewed annually, on a number of weather problems of vital interest to the public. These include the detection, tracking, and prediction of tornadoes and hurricanes, long-range forecasting, fallout of radioactive debris, and other subjects.

The statement on weather modification, approved by the society's council, is as follows:

The council of the American Meteorological Society has assumed the responsibility for issuing periodic statements on the scientific aspects of weather modification and control. Two previous statements were issued in 1951 and in 1953. In view of the additional information on this subject that has become available in the interim, the council deems it desirable to issue a revised statement of its opinion at this time.

1. The seeding of supercooled cloud with dry ice will usually convert at least a portion of the cloud to ice crystals. Under appropriate conditions, such seeding may release variable amounts of precipitation from fairly deep and active cumulus clouds in which the natural release of precipitation has not already started. Small, inactive cumulus clouds are usually dissipated when they are seeded with dry ice. Holes or valleys may be produced in supercooled layer clouds or supercooled fogs by seeding them with dry ice.

2. The injection of water drops or hygroscopic salt particles into active, warm (nonsupercooled) cumulus clouds may release some rain. Small, inactive, warm cumulus may often be partially or completely dissipated by seeding them from above with water drops or other particles; such dissipation may occasionally be accompanied by the release of very light rain.

3. In some cases warm fog and stratus may be dissipated in restricted regions by the use of certain hygroscopic materials.

4. At temperatures below about −5° C. silver iodide crystals are known to affect supercooled clouds in much the same way as dry ice. The frequent absence of clear-cut results following the operation of ground-based silver iodide generators is believed to be due to one or more of the following causes: (*a*) The failure of the seeding material to reach the supercooled clouds, (*b*) the absence of clouds that could be affected by seeding, (*c*) the decay of the silver iodide, (*d*) the presence of an ample supply of natural ice crystals, (*e*) topographical influences which defy quantitative measurement.

5. Cloud seeding acts only to trigger the release of precipitation from existing clouds. The release of substantial amounts of precipitation by either nat-

ural or artificial means requires the preexistence of an extensive moisture supply in the form of moist air currents and of active cloud-forming processes. For this reason the meteorological conditions most favorable for the artificial release of precipitation are very much the same as those which usually lead to the natural release of precipitation. This factor plus the extreme natural variability of precipitation makes the evaluation of the effects of seeding difficult and often inconclusive.

6. Evaluations performed by independent agencies have yielded reasonably convincing evidence of increases of precipitation due to the operation of ground-based silver iodide generators only for operations conducted in cold weather in regions where forced lifting of the air over a mountain range is an important factor. No convincing evidence has been presented which indicates that ground-based silver iodide seeding affects the amount or character of the precipitation over flat country. This does not prove that there are no such effects, but suggests that, if present, they are too small to be detected by statistical analyses of data available to this date.

7. In the absence of a truly quantitative theory of precipitation, the best present means of obtaining a quantitative estimate of the effect of seeding on precipitation is through the statistical evaluation of randomized cloud-seeding experiments. The randomization is necessary to insure valid interpretation of the results, and a long series of such experiments may be necessary to detect small effects.

8. Present knowledge of atmospheric process offers no real basis for the belief that the weather or climate of a large portion of the country can be significantly modified by cloud seeding. It is not intended to rule out the possibility of large-scale modifications of the weather at some future time, but it is believed that, if possible at all, this will require methods that alter the large scale atmospheric circulations, possibly through changes in the radiation balance.

9. All cloud-seeding operations should be considered as experiments, since the techniques are still under development and there is no sound basis for the quantitative estimation of the results in advance of the operation. As experiments they should be designed primarily to yield optimum scientific results. There is good reason to believe that improved returns from cloud seeding will result from a sound experimental approach and this should be fostered by all concerned.

Senator WATKINS. May I say, in a few places I didn't read the entire statement. Will the record show the entire statement read?

Senator YARBOROUGH. Yes, sir. Your entire statement will be part of the record.

Senator WATKINS. Thank you.

Senator YARBOROUGH. Thank you, Senator Watkins, for that very thoughtful statement.

The next witness is Dr. F. W. Reichelderfer, Chief of the Weather Bureau of the Department of Commerce.

STATEMENT OF F. W. REICHELDERFER, CHIEF, UNITED STATES WEATHER BUREAU, DEPARTMENT OF COMMERCE

Dr. REICHELDERFER. Mr. Chairman, my name is F. W. Reichelderfer, Chief of the United States Weather Bureau, and I am here representing the Department of Commerce.

First, I should refer to the letter addressed to Senator Magnuson already mentioned, which gives the Department's position with reference to S. 86. Unless the chairman wishes, I will not read that entire letter, although it should go in the record as the Department's position.

Senator YARBOROUGH. Any objection to placing that in the record?

Senator SCHOEPPEL. None whatever. I think, as a matter of fact, Senator, it ought to go into the record as a part of this proceeding.

Senator YARBOROUGH. The letter will go into the record in its entirety.

(The document referred to above is as follows:)

DEPARTMENT OF COMMERCE,
WEATHER BUREAU,
Washington, May 14, 1957.

Hon. ALAN BIBLE,
Chairman, Subcommittee of Committee on Interstate and Foreign Commerce, United States Senate, Washington, D. C.

DEAR SENATOR BIBLE: In the hearings yesterday on Senate bill S. 86, members of the committee requested information about the forecasting of tornadoes and possible means of modification or control of these most destructive local storms. Among major developments in meteorology during recent years, the two that offer greatest promise for knowledge and understanding of tornadoes, knowledge prerequisite to "control," are the storm-detection radar and the electronic weather computer. Violent vortices that produce the destructive forces of tornadoes are short-lived, rather local, phenomena. Conceivably, there are ways to "foil" such vortices, if sufficient counterforces were exerted at the right time and place. The forces required probably would be large, but the immediate difficulty is detection of the right time and place in each case. Research studies have been made of this subject, and with recent developments in meteorology more intensive research is planned. The potential savings in life and property would justify greatly increased research efforts now.

One of the possible "tools" in tornado research and development of countermeasures is the seeding of clouds. Under some circumstances, seeding dissipates clouds, and use of great quantities of artificial cloud-seeding material might reduce cloud growth and development of extreme instability which produce tornadoes. Although this method does not now appear to be the most promising approach, it is of interest in the current discussion because it shows the relationship of cloud-seeding experiments to research in fundamental problems in meteorology, including forecasting as well as cloud modification. Because of the fundamental character of these problems, the Weather Bureau has carried on basic research by aircraft and radar operating in the vicinity of tornado situations. Much progress hs been made in recent years by the Bureau and cooperating tornado-research and warning centers in the Midwest. It is confidently expected that extension of this research, using several different approaches that appear promising, will bring further improvements and reveal the best possibilities for reducing the destructive effects of these storms.

In the joint statement submitted to your committee yesterday, suggestion was made for basic research under direction of the National Science Foundation, and experimental operations in cloud seeding under one or more interested Government departments. I believe the best and most expeditious approach to development of the practical applications of tornado control measures, cloud seeding, and other meteorological problems that are more or less interrelated, is through research directed toward a thorough understanding of these phenomena. This involves basic research, not only in the laboratory but, even more important, in the atmosphere under the conditions found in nature during formation of clouds, rain, and severe storms. This well-planned and coordinated experimental program, both in the field and in the laboratory, is in contrast to the hit-or-miss rainmaking operations, the results of which cannot be evaluated. For a general research program of this kind, in which several departments and agencies are interested, I believe the leadership and coordination should be placed in a permanent scientific research organization. The National Science Foundation, with its general responsibilities in research, appears to be the logical organization to provide whatever overall coordination may be necessary and desirable, while the operational phases might be carried on by the departments most concerned, either by direct operations or through contract with other private or public institutions engaged in this work.

Sincerely yours,

F. W. REICHELDERFER,
Chief of Bureau.

Hon. WARREN G. MAGNUSON,
Chairman, Committee on Interstate and Foreign Commerce, United States Senate, Washington, D. C.

DEAR MR. CHAIRMAN: Your letter of January 11, 1957, requested the views of this Department with reference to S. 86, a bill to provide for an experimental research program in cloud modification.

The bill would authorize and direct the Advisory Committee on Weather Control to formulate and conduct, both through contract and, in effect, by a grant-in-aid to State agencies, a 5-year program of research in cloud modification. Further, an amount not to exceed $5 million is authorized for the program, with the restriction that one-fourth of the annual appropriation should be made available for that part of the program to be accomplished through contract, and three-fourths should be made available for the cooperative program to be matched equally by the States.

A review of the extensive experimentation in cloud seeding which has been undertaken throughout the world indicates that the results to the present time have been inconclusive and indefinite. It is clear, also, that progress in rainmaking operations, which potentially has the possibility of developing into a technically sound and respected field of meteorological engineering, has been retarded in recent years by the lack of coordination among the diverse experimental activities carried on by numerous public and private agencies. In addition, it is recognized that a major difficulty has been the fact that there are so few research institutions qualified and equipped to carry out an adequate program of experiments in this field.

The Department believes it would be unsound to undertake further exploitation of arid-region rainmaking before adequate methods have been developed. The history of the many hit-or-miss seedings undertaken during the past 5 years bears out the conclusion that a program based on a number of uncoordinated experiments will tend to delay rather than promote progress in rainmaking techniques.

In view of the foregoing, it is our conviction that a more expeditious and economical approach to the development of weather modification techniques would be to center responsibility for the planning and coordination of an adequate program in the National Science Foundation and to authorize that agency to make arrangements for research activities by those private and public institutions that are in a position to make the best use of scientific personnel and facilities available. We are convinced this solution to the problem would result in the required comprehensive program at reasonable cost, and would foster cooperation with private organizations and the States in the development of this important meteorological phenomena.

The Department believes that sufficient authorization to carry out this program already exists in present legislation governing the activites of the National Science Foundation and other cooperating Federal agencies having an interest in this matter. However, in order to undertake the activities as proposed in S. 86, additional funds would have to be appropriated.

For the above reasons, the Department of Commerce recommends against enactment of S. 86.

Sincerely yours,

L. S. Rothschild,
Acting Secretary of Commerce.

Dr. Reichelderfer. Mr. Chairman, the statement that has been submitted to the committee and that I would like to read in part has been written on the basis that this subject we are discussing is an extremely important one because of its relation to water supply, an extremely important national problem.

The Weather Bureau and the Department of Commerce quite naturally are very much interested in this subject, and in the possibilities, the possible development, of additional means to supplement the water supply.

We have watched for a number of years and carried on considerable research, and we have seen the confusion that has developed, confusion over which we are very much concerned, as is this committee and many other people. It seemed appropriate, therefore, to make a statement that is quite clear, perhaps pointed in a few places.

I would like to make it clear that on some aspects apparently everybody agrees, the need for more research, the need to find out what the possibilities of cloud seeding are, and any other means for weather modification.

I would like it understood, therefore, that in speaking quite plainly, I am not criticizing, I am trying to bring out in words about which there can be no question, the points which are extremely important in bringing out the facts as we see them.

Although many thousands of rainmaking experiments have been made during the past 10 years in various parts of the world, and many millions of dollars have been spent in cloud-seeding research, the results have been inconclusive. A new research approach to the problems of weather modification is necessary to determine what is fact and what is fancy. Many rainmaking operations have been hit-or-miss attempts and the results difficult to evaluate. The "evidence" in many cases may be interpreted to indicate diminished rainfall following cloud seeding rather than the intended increase.

The facts probably are that in most cases seeding of shower-type clouds has had no practical effect on the amount of rain or snow that reached the ground. Many claims have been made to success in rainmaking, in cases where cloud seeding could not possibly have caused rain. Several actual cases for which we have charts and diagrams here, show how very easy it is to draw the wrong conclusions from a complex sequence of physical events that accompany natural formation of clouds and precipitation.

In weather, with its many variables, some indeterminate at present, the "post hoc" fallacy frequently leads to mistakes as to cause and effect. Meteorological folklore is full of sayings in which chronological sequence has been mistaken as indication of a cause and effect relationship.

If I may, Mr. Chairman, I would like to show these charts. It will only take a few minutes, and I think they will say more than I could say in many words.

With respect to the examples from meteorological folklore, one has been mentioned by Senator Watkins, I believe, in which he mentioned the relationship, the supposed relationship, of cannonading to artificial rainmaking. There are many others. One is the old saying that showers cool the air. Now in a few cases showers may cool the air, but in most cases it is the other way around. The cold air coming down from the Arctic causes the showers, and it is only the complex sequence and the timelag that has caused people in general to believe that showers cool the air, rather than vice versa, which is the fact.

These are a number of actual cases which illustrate why, in my opinion—and I am speaking for the Weather Bureau—it is extremely important to look at these facts very clearly, because it is easy to be misled.

This is a case in Texas in 1953. These lines show the rainfall that resulted during a month when cloud seeding was carried on. Here is a line showing 10 inches of rain during the month. Here is a line showing 15 inches of rain during the month. Here the lowest point is five-tenths of an inch. The target area is here; the generators were situated so that the wind would carry silver iodide toward the target area.

There doesn't seem to be any effect. You see the target area is right on one of the below-average rainfall lines; it is on the 4-inch line.

Senator SCHOEPPEL. To clarify your chart for the benefit of the committee here, is the target area in red there?

Dr. REICHELDERFER. The target area is in red. Here is another in May 1953. Now this is a case where I think these data, which are official data, appear to prove a conclusion which doesn't represent the actual facts. Because you will see the target area, the red area in this case is in a loop in the drier Isohyets, the less rainfall, so that it would appear that cloud seeding caused less rainfall. We don't think that is the case. We just say that the cloud seeding didn't do anything in this case.

Senator CASE. Dr. Reichelderfer, do you know what type of clouds were seeded?

Dr. REICHELDERFER. The records are not complete. Presumably there were some stratus clouds, some cumulus clouds. In April and May in that part of the country, they occasionally have stratus clouds; most of them are cumulus clouds.

Senator CASE. Most of them were cumulus clouds?

Dr. REICHELDERFER. Shower-type clouds.

Senator CASE. Do you know what method of seeding was used?

Dr. REICHELDERFER. All ground generator, I believe.

Senator CASE. Do you know what elevation the cumulus clouds had?

Dr. REICHELDERFER. This chart was for the entire month, so the height would vary considerably. These are the cumulative effects of seeding during the entire month.

Senator CASE. I think that is a very good illustration for the point that Dr. Reichelderfer made, that you need more research, because I think the type of seeding has to take account of the type of clouds involved.

Dr. REICHELDERFER. No question about it.

Senator CASE. It is hard to evaluate an experiment if you don't know the conditions of the experiment or the technique used.

Dr. REICHELDERFER. This, Senator, is, in a brief word, the reason we are so concerned about this whole subject and the reason my statement is quite blunt in parts.

Senator CASE. I think your point is well taken, that you need more research and it has to be interpretative of conditions and techniques.

Dr. REICHELDERFER. Yes, sir.

Senator YARBOROUGH. Dr. Reichelderfer, is there any evidence as to whether or not this ground-seeding attempt in the particular area depicted on the chart now before the committee, whether that ground seeding actually reached the clouds or not?

Dr. REICHELDERFER. This we don't know. We have been able to examine some cases where we think they did not—the seeds did not reach the cloud.

Senator YARBOROUGH. But there was no data kept on that in this particular area?

Dr. REICHELDERFER. At least we didn't have access to all of the data.

The second one: Now, in cloud-seeding operations it is quite natural that the seeders who are looking for results attack the best, the most promising clouds. There have been some efforts to obtain a cloud census, and there are figures of the order of 20, 30, 40 percent of the cases of clouds that show promise to develop into shower clouds: 30, 40 percent, rather large, do actually develop into shower clouds,

even though there is no seeding. So that the cloud seeder, therefore, who seeds an active cumulus cloud is betting on a thing that comes true by natural causes in 30, 40, or 50 percent of the time.

This is an illustration of how wrong conclusions can be drawn. In this case they seeded clouds which already showed tendency to develop into showers. These areas here show it.

The operators seeded one of these clouds—it may have been a very small protuberance, bulge in the clouds. And this cloud eventually developed into a shower cloud, with false cirrus. It was thought that the seeding had caused the cloud. But this doesn't appear to be the case—I should say seeding did not cause the cloud to grow. It doesn't appear in this case that this could have been possible, because a review of the circumstances shows that the clouds were above freezing; the dry ice, therefore, would have melted if dry ice had been used, and it is too high a temperature for silver iodide to be effective.

The minimum effective temperature of dry-ice seeding is about −4° C., and this temperature was three or four thousand feet higher in altitude. Silver iodide begins to be effective at about −10°, so it could not have been effective in this case. I show this—it seems quite clear that the seeders thought they had caused rain which they couldn't possibly have caused under these circumstances.

The third case is somewhat similar. Some of the previous witnesses have spoken about the coalescence process of forming rain. This is a case of a tropical shower. The seeding was with ground generators. The witnesses felt quite sure that the seeding had caused the cloud to develop into a shower.

Subsequent study by an independent group or disinterested group showed that the shower actually started, it might have been by the coalescence process, the raindrops bumping together, before the cloud reached freezing level, which rules out both dry ice and silver iodide. In this case silver iodide was used. A plane was flying along at the freezing level as the cloud pushed on up to higher altitudes where the artificial nuclei would have to reach before they could be effective, and it was snowing, and the snow fell into the plane, in sufficient volume to be noticed in the cockpit of the plane, showing that there were many times the number of natural nuclei present that were required for the shower to develop into a thunderstorm. The number of silver iodide generators needed to produce this effect that came naturally was between 200 and 20,000. We don't know. There were actually only three generators used.

This conclusion only says that here is another case where witnesses felt quite sure the silver iodide had produced the shower, but there seems conclusive evidence that the shower came entirely from natural causes.

Moving on quickly: Here is another case where a further look into the data gives evidence which we do not regard as real evidence at all. We are presenting it only to show that with evidence available now, nobody knows what the actual results are under present seeding without sound experimental circumstances.

Here in this chart is heavier rainfall, an inch and a half—this was a specific case, one day—an inch and a half of rain. The seeding was started here. There was less rainfall through here. If you want

to draw conclusions, it looks like the seeding reduced the rainfall. We don't insist that this is true but this is what the evidence says.

Senator CASE. What type of seeding was that?

Mr. REICHELDERFER. This was airplane seeding, seeding from aircraft.

The next to the last one that I would like to show, refers to the condition that you mentioned a moment ago, Senator. In many cases we know that seeding is done with ground generators in the cold air of a frontal system. In this case it is a warm front. Now this line marks a temperature inversion, where the temperature, instead of decreasing with altitude, remains constant, or increases. If there were any circulation across this line, the line would disappear, because as this air rises, it expands adiabatically, and this makes the temperature decrease so that the line disappears.

You can't have circulation from down here up through here directly. It would wipe out the inversion.

Generators are operated under the inversion, showers occur from the warm moist air from the gulf rising above the front. The showers couldn't possibly have occurred from the seeding.

The final chart is similar to the one I showed a moment ago. This is a natural pattern of rainfall. This was 1952. The target area was here, the control stations were here, and also here, and the generators were down in this locality. [Indicating.]

Now here is a green area with maximum 5 inches of rainfall. There is a low rainfall strip in between. Here there was 3 inches of rainfall. Up here, 4 inches of rainfall. Obviously as has been stated before, the variability in rainfall is so great that we can draw no sound conclusion from this.

If you want to draw conclusions, certainly the seeding did not cause any of these peaks, rather it points toward decrease.

The next part of my statement refers to the American Meteorological Society statement that Senator Watkins mentioned and I will say only: On April 30, 1957, the Council of the American Meteorological Society, largest scientific organization of meteorologists in the world, issued a statement on weather modification. Copy is attached. If the statement seems detailed and somewhat involved, it is because the phenomena involved in cloud seeding are themselves complex and have many ramifications.

If my entire statement may go in, I will skip some here that seems to be repetitive.

Senator YARBOROUGH. Your entire statement will go into the record.

Mr. REICHELDERFER. Thank you.

Among other conclusions, there are three pertinent to my remarks that are implied in the AMS statement.

1. Seeding of supercooled clouds in winds blowing upslope over a mountain range may increase the snow storage for irrigation purposes. During cold weather increase in snowfall by this means may be as high as 15 or 20 percent.

2. In flat country the effects, if any, of cloud seeding in terms of rain or snow to reach the ground are too small to be detected by evaluation methods so far developed. Evidence is conflicting. Sometimes seeding is followed by growth of the cloud, at other times, by dissipation of the cloud. Present explanations are inadequate as

to why increase may occur in some cases, decrease in others, and in still others, no practical change beyond conversion of supercooled cloud droplets into ice crystals, a change that is often an impressive spectacle in itself but may be without practical results in precipitation to reach the ground.

Obviously, research is needed to diagnose the physical conditions of the individual cloud and determine factors that make seeding effective, also whether seeding will cause the cloud to grow in the given case, or to decrease in size and interfere with formation of showers.

3. Cloud seeding is not a cure for general drought. (OUR NOTE: Persistent and widespread droughts as well as the dry climates of permanent arid regions are results of general air mass and wind circulation patterns of the atmosphere encompassing vast expanses of air. Under chronic drought conditions, clouds are usually absent and when clouds are present the precipitable moisture in the air is practically always too little for cloud seeding to produce rain that reaches the ground.)

After years of experimentation in cloud seeding all over the world, why are present conclusions so indefinite as regards the effects of cloud seeding in individual cases? There are several good reasons. First, the factors in formation of clouds and showers are complex and variable. As yet, no specific tracer has been found for distinguishing rain or snow produced by natural causes from that which may be induced by nuclei put into the atmosphere artificially. Nuclei counters to measure the condensation particles in the air are still in an experimental stage and it is not yet practicable to determine in any particular case whether there is a deficiency of nuclei or an excess for formation of clouds and precipitation.

Also, methods have not yet been developed for determining whether artificial nuclei reach those parts of the cloud where they might be effective.

Dr. Schaefer mentioned that another source of uncertainties at the present stage in cloud seeding is the premature claims in the early years of cloud seeding which led to popular expectation of phenomenal results in rainfall and storm modification. It was seriously stated by some experimenters that cloud seeding had caused widespread heavy rains and major floods, that seeding had diverted a hurricane from its natural course, and caused other comparable large-scale effects. These claims insofar as past experiments are concerned have now been discredited although this does not mean that further possibilities of weather modification have been disproven. On the contrary, development of the practical possibilities has been delayed by fallacious post hoc conclusions as to cause and effect in cloud seeding and storm relationships.

During the period of time when these earlier experiments were being made, there were strong international pressures that led the top planning group to place greatest emphasis on investigation of the possibilities of large-scale effects of cloud seeding.

The Weather Bureau and other research agencies regarded an understanding of cloud physics and an adequate quantitative theory of rain formation as a prerequisite step before artificial rainmaking could be carried on intelligently, but their repeated recommendations

in support of such research had to give way to the more immediate search for large-scale effects.

The extravagant claims of 5 to 10 years ago, together with the now largely disproven claims of the hit-or-miss rainmakers have diverted attention and support from realistic research and development of cloud-seeding possibilities and have greatly delayed real progress in this primary program.

Another reason for the present undeveloped state of cloud seeding is found in the fact that no single agency or institution has had the research facilities and support necessary to do a thorough job. Although some phase of this research can be carried on independently by different research institutions, the basic problem is development of an adequate, quantitative theory of precipitation, particularly shower-type precipitation, and this problem can best be solved by a comprehensive and coordinated research program with aircraft fully equipped as flying laboratories to measure the component elements so that the overall process of rain formation can be analyzed. Considerable progress toward this goal was made several years ago in the Thunderstorm project, a cooperative undertaking among several Government agencies and research institutions, but this project was discontinued pending development of better techniques for extending the essential observations and measurements.

Without taking time to review in detail the history of cloud seeding and rainmaking during the past 10 years, your committee may be interested in an indication of the scope and very extensive activities that have been devoted to this subject. In its report No. 13, published in 1955, the World Meteorological Organization gave a digest of results up to that time. The summary contains in substance about the same conclusions as those given in the recent statement of the American Meterological Society. Two other references pertaining to this research are enclosed. One is headed "Chronology of Major Federally Sponsored Research and Evaluation Programs Relating to Cloud Modification and Artificial Rainmaking." The other is a seven-page list of "Weather Bureau Papers and Publications on Cloud Physics and Rainmaking Since 1947." These include many contributions to basic understanding of the physical constants and mechanisms that must be understood in order to develop specific techniques for cloud modifications that will make known in advance what the results will be, whether clouds will be increased when desires and not diminished or vice versa.

A review of rainmaking shows that this undertaking which might be developed into a technically sound and respected field of meteorological engineering has been plagued almost from the beginning with too many amateurs and too few experts. The number of research institutions equipped to carry on well-designed and thorough studies in this subject is small and the number of scientists with research capabilities combining knowledge of physics and meteorolgy is small also.

In this brief statement we have said that by the very nature of the problem a comprehensive and well-coordinated program is necessary with provisions for observations and measurements by aircraft as part of the required research facilities.

In the present stage of development, it would delay rather than hasten progress if the limited number of research facilities were divided among a larger number of research institutions by bringing new operators and new contractors into the field and the limited research facilities were divided among a larger number of research institutions by bringing new operators and new contractors into the field who would compete with each other for expert staff and financial support. It would be a mistake to encourage further exploitation of arid region rainmaking before we have techniques for distinguishing between cases where cloudseeding may diminish rainfall rather than increase it. The many hit-or-miss rainmaking operations which lack reasonably satisfactory experimental designs would only confuse and delay the research program. The record of the past 5 years of hit-or-miss seedings shows this conclusively.

After extensive studies of the subject, the scope of which is shown in the enclosures, it appears that the most expeditious and least costly approach to development of weather modification is to place the planning and coordinating responsibility in the hands of one of the established research agencies of government, preferably the National Science Foundation, and to authorize that agency to support and contract for research with those institutions best qualified to carry on this work and so situated as to make the best use of the scientific personnel and the facilities available for the purpose. This would provide a comprehensive and well-coordinated program at minimum cost and would foster cooperation in this important development. It would be a new approach which would promote progress on a sound basis.

(The supplements to Mr. Reichelderfer's statement are as follows:)

CHRONOLOGY OF MAJOR FEDERALLY SPONSORED RESEARCH AND EVALUATION PROGRAMS RELATING TO CLOUD MODIFICATION AND ARTIFICIAL RAINMAKING

Government interest in the possibilities of cloud seeding and rainmaking was resumed with the announcement by the General Electric Co. on November 14, 1946, that one of its scientists (Dr. V. J. Schaefer) had converted a subcooled cloud to ice crystals by seeding from an airplane in the vicinity of Mount Greylock in western Massachusetts the preceding day. This led directly and indirectly to the establishment of a number of major Government-sponsored programs to explore and evaluate the possibilities and limitations of artificial techniques for modifying clouds and inducing precipitation.

February 28, 1947: Project Cirrus was established under contract with the General Electric Co. by the United States Army Signal Corps in cooperation with the Office of Naval Research. This exploratory field-research program continued until September 30, 1952, and included the assistance of the Air Force and Weather Bureau.

April 4, 1947: Official in charge, Portland Weather Bureau Office, cooperated on a cloud-seeding flight (Larch Mountain). According to the Portland Oregonian, June 1, 1947, this was the first case to make snow hit the ground. Weather Bureau published "Narrative Report on the Experiment for Production of Artificial Snow at Portland, Oreg., April 4, 1947," by E. S. Ellison.

April 16, 1947: Thunderstorm project authorized to conduct exploratory seeding tests during the summer in connection with its air operations (AF, NACA, USN, and USWB).

August 1947: Fundamental laboratory and field studies of the mechanics of cloud formation and precipitation growth launched by newly established Physical Research Division (USWB). This research continues to date.

August 19, 1947: Air Force and Weather Bureau decided to jointly conduct extensive cloud seeding tests (cloud physics project) using the facilities at

Wilmington, Ohio. The Navy and National Advisory Committee for Aeronautics continued their cooperation in support of air and ground activities. Systematic tests began in October and continued at this location during the winter and summer of 1948.

November 1948: Ground seeding experiment established at Colfax, Calif., which operated with a silver iodide generator on a cyclical basis from November 1948 to April 1949 (USWB).

Circa 1949: Geophysical research directorate of the Air Force began a program of laboratory and contract research on the physics of nucleation and growth of precipitation elements and the action of artificial nuclei. The program has included studies of natural cloud structure using specially instrumented aircraft and radar facilities. The program is continuing to date.

February 15, 1949: Cloud physics project began seeding operations in the vicinity of Donner Pass of the Sierra Nevada Range northeast of Sacramento, Calif. Tests were continued until April 7, 1949 (AF, USWB).

May 9, 1949: Cloud physic project began a 2-month period of cumulus seeding tests from Brookley Air Force Base, Mobile, Ala. (AF, USWB).

Circa 1950: United States Army Signal Corps carried out studies of cumulus cloud structure using research aircraft, including laboratory and field studies of the nucleation properties of dry ice and silver iodide.

February 1950: Weather Bureau began a 3-year cooperative evaluation of a cloud seeding project conducted by the California Electric Power Co. resulting in a statistical estimate of a 9-percent increase in runoff from the watershed during the seeded period.

November 1950: An extensive evaluation of Project Cirrus operations including claims that periodic seeding with a silver iodide generator had exercised a profound modification of weather over a 2-year period was started. The preliminary results were presented at a seminar in January 1952, at which Dr. Langmuir was present (USWB).

July 1951: Army, Air Force, Navy, and Weather Bureau initiated a comprehensive survey of cloud seeding techniques and results under a special advisory group on artificial cloud nucleation appointed for the purpose of developing recommendations for further Government research in this field.

July 1951: Instrumentation of 800 feet mineshaft at Globe, Ariz., to be used in cloud physics investigations completed by Physical Research Division of USWB. Measurements of the various physical properties of artificial clouds were begun.

September 1951: Department of the Interior sponsored cloud seeding operations in Pacific Northwest. Results were evaluated by an interagency committee.

January 1952: Weather Bureau contracted with the University of New Mexico to conduct an evaluation of a commercial cloud seeding project in western New Mexico and southeastern Arizona.

May 1952: Department of Defense research agencies and the Weather Bureau began preliminary plans for several coordinated large-scale cloud seeding projects, known as the artificial cloud nucleation program, as a result of recommendations submitted by the advisory group. These arrangements provided excellent cooperation and coordination between Government agencies and with universities and other private groups.

July 1952: Cloud physics laboratory established at Hitchcock, Tex. Instrumentation of 3,000 cubic meter cloud chamber commenced with termination of work in the Globe, Ariz., mineshaft. This facility is still in use (USWB).

November 1952: United States Army Signal Corps began a 3-year field test program for a systematic investigation of stratus cloud dissipation by dry ice and silver iodide seeding.

Circa 1953: Weather Bureau began collaboration in a 2-year study of the status and results of cloud modification experiments on a worldwide basis under the auspices of the World Meteorological Organization resulting in the publication of a summary report in 1955.

January 1953: New York University, under contract with the Office of Naval Research, commenced field tests to evaluate the effects of seeding on storm generation along the east coast. Winter operations continued until April 1954.

March 1953: Weather Bureau began operations of its phase of the artificial cloud nucleation program from Seattle, Wash., which continued until May of 1954 for the purpose of evaluating the effects of seeding in temperate latitude storms over southwestern Washington.

August 1953: Under contract with the Air Force, the Department of Meteorology of the University of Chicago began extensive flight operations in connection with cumulus cloud seeding evaluations. Operations were carried out in the Carribbean and over the Midwest through November 1954.

Summer 1953: Project Skyfire, a cooperative investigation of the possibilities of cloud seeding to suppress lightning over forested areas, began. Exploratory seeding operations commenced in 1956 (USDA, ACWC, USWB).

August 13, 1953: Legislation (Public Law 256) establishing the Advisory Committee on Weather Control was signed into law.

August 1955: Operation Overseed began at Mount Washington, N. H., under the sponsorship of the Advisory Committee on Weather Control, to obtain field data on the dispersal of silver iodide from ground generators and its effects on clouds. Operations continued until June 1956.

October 1955: First reports covering the statistical phases of the analysis of the data obtained during the artificial cloud nucleation projects completed and submitted for publication as a monograph of the American Meteorological Society.

Spring 1956: Exploratory seeding experiments and freezing nuclei measurements conducted in vicinity of Dallas, Tex., and Flagstaff, Ariz., under auspices of Advisory Committee on Weather Control.

August 1956: Project Seabreeze conducted near Boca Raton, Fla., to evaluate possibility of causing systematic effects on triggering premature freezing of cloud droplets (ACWC).

December 1956: Project for measuring freezing nuclei initiated in Carribbean area in cooperation with Australian Commonwealth Scientific and Industrial Research Organization (USWB).

January 1957: A 3-year randomized ground seeding project began in the vicinity of Santa Barbara, Calif., involving the cooperative efforts of public and private organizations, including several interested Federal agencies.

NOTE.—The foregoing chronology does not include numerous specific cloud physics and related investigations launched in Government and university laboratories, which have been sponsored by interested Federal agencies, such as the Air Force Cambridge Research Center, the Office of Naval Research, National Science Foundation, the National Advisory Committee for Aeronautics, and the Weather Bureau.

The estimated cost of past cloud-seeding experiments by the Federal Government is of the order of $10 million.

Hundreds of commercial operations have been conducted since around 1948, mostly without adequate experimental precautions. The results of independent evaluations of these operations by Government and university groups have been inconclusive or negative except for statistical evidence suggestive of increases of 10 to 15 percent in several areas along the west coast. A few evaluations have been suggestive of decreases (Florida, Canada).

DEPARTMENT OF COMMERCE,
WEATHER BUREAU,
Washington, D. C.

UNITED STATES WEATHER BUREAU PAPERS AND PUBLICATIONS ON CLOUD PHYSICS AND RAINMAKING SINCE 1947

Rainmaking, by one means or another, has been attempted from time to time for many decades—or even centuries. In fact, man's interest in weather modification can be traced back through records and artifacts to the stone age. Serious proposals for carrying out rainmaking experiments by shooting explosives into clouds followed the Napoleonic wars, and were revived after the Civil War.

In 1892, Congress appropriated $9,000 for rainmaking experiments by cannon fire under direction of Gen. Robert G. Dyrenforth. Although it had long been thought that cannonading caused rain, it has since been found that the rainfall that often followed battles is accounted for in other ways; the legend in this connection is one of many illustrations of the likelihood of "post hoc" mistakes in jumping to conclusions in weather causes and effects. In 1923, a method was attempted in which clouds were treated with electrified sand dispensed from an

airplane. Other experiments involving spraying, liquid air, and throwing dust into clouds were also conducted in the early 1920's. Around 1930, experiments with dry ice were tried in Europe.

The subject of rainmaking is so important and of such universal interest that technical articles and publications in this field now number over a thousand and are too numerous to list here. Hundreds of excellent papers on the subject have been published by meteorologists here and abroad in recent years. Rather than include an incomplete list of these, it seems preferable to confine this list to articles by Weather Bureau authors. The importance of the subject to the Bureau and its public services rests not only in rainmaking as such, but in the fact that its success is based on deficiencies in natural precipitation nuclei, a factor which, if rainmaking is practicable, is bound to be an important condition in forecasting rain and storm. If lack of nuclei sometimes prevents formation of rain and storms, these conditions must be measured regularly by the Bureau if its forecasters are to have the data necessary for accurate rain forecasting.

The Weather Bureau's major research efforts in cloud physics and rainmaking began shortly after the November 1946 announcements regarding cloud seeding. Some of the following publications resulted from cloud studies already underway at that time in collaboration with other agencies. They are included here because of their important bearing on cloud structure and characteristics of major significance to the physical aspects of the cloud-seeding evaluation problem.

1947

The Electrical Charge on Precipitation at Various Altitudes and Its Relation to Thunderstorms (Gunn). Phys. Rev., V. 71, 181–186, Feb. 1947.

In-Flight Icing of Highly Electrified Aircraft (Gunn). J. Aeronautical Sci., V. 14, 527–528, Sept. 1947.

Icing Zones in a Warm-Front System With General Precipitation (Lewis). NACA TN 1392, 1947.

A Flight Investigation of the Meteorological Conditions Conducive to Aircraft Icing (Lewis, Line and Steinmetz). NACA TN 1425, 1947.

1948

Observations of Middle and Lower Cloud Composition During Winter and Spring (Lewis). Monthly Weather Review, V. 76, 1–9, Jan. 1948.

First Partial Report on the Artificial Production of Precipitation: Stratiform Clouds, Ohio, 1948 (Coons, Gentry and Gunn). Research Paper No. 30, U. S. Weather Bureau, 1948. Summary published in Bull. American Meteor. Soc., V. 29, May 1948.

Electric Field Intensity Inside of National Clouds (Gunn). J. Applied Phys., V. 19, 481–484, May 1948.

1949

Second Partial Report on the Artificial Production of Precipitation: Cumuliform Clouds, Ohio 1948 (Coons, Jones and Gunn). Research Paper No. 31, U. S. Weather Bureau, 1949. Summary published in Bull. Amer. Meteor. Soc., V. 29, Dec. 1948.

Production of Artificial Precipitation, Third Partial Report: Orographic Stratiform Clouds, California, 1949, Fourth Partial Report: Cumuliform Clouds, Gulf States, 1949 (Coons, Jones and Gunn). Research Paper No. 33, U. S. Weather Bureau, 1949. Summaries published in Bull. Amer. Meteor. Soc., V. 30, Sept. and Oct. 1949.

Investigation of Meteorological Conditions Associated with Aircraft Icing in Layer-Type Clouds for 1947–48 Winter (Kline). NACA TN 1793, 1949.

Observations of Icing Conditions Encountered in Flight During 1948 (Lewis and Hoecker). NACA TN 1904, 1949.

The Terminal Velocity of Fall for Water Droplets in Stagnant Air (Gunn and Kinzer). J. Meteor., V. 6, 243–248, Aug. 1949.

Electronic Apparatus for the Determination of the Physical Properties of Freely Falling Raindrops (Gunn). Rev. Sci. Instrs., V. 20, 291–296, April 1949.

The Free Electrical Charge on Thunderstorm Rain and Its Relations to Droplet Size (Gunn). J. Geophys. Res., V. 54, 57–63, Mar. 1949.

1950

The Importance of Artificial Nucleation for the Production of Precipitation (Lewis). Trans. N. Y. Acad. Sciences, Ser. II, V. 12, 264–267, 1950.

A Short Bibliography on Artificial Production of Precipitation, June 1, 1950 (revised August 1, 1955).

Free Electrical Charge on Precipitation Inside an Active Thunderstorm (Gunn), J. Geophys. Res., V. 55, 171–178, June 1950.

1951

Comments and Communications—Dr. Langmuir's Article on Precipitation Control (Hall et al.), Science, V. 113, Feb. 16, 1951.

Cloud Seeding Methods (Hall), 1951 (for issuance in response to public inquiries in this field).

Meteorological Analysis of Icing Conditions Encountered in Low-Altitude Stratiform Clouds (Kline and Walker). NACA TN 2306, 1951.

Analysis of Meteorological Data Obtained During Flight in a Supercooled Stratiform Cloud of High Liquid Water Content (Perkins and Kline). NACA Rm E51D18, July 11, 1951.

Precipitation—Natural and Otherwise (Wexler). Paper presented before American Society of Agriculutral Engineers. Houston, Tex., 19 June 1951, and the Great Plains Agricultural Council, Laramie, Wyoming, 3 Aug. 1951.

An Evaluation of the Technique of Cloud Seeding to Date (Hall). Trans. N. Y. Acad. Sciences, Ser. II, V. 14, Nov. 1951.

Evaporation, Temperature and Thermal Relaxation Time of Freely Falling Waterdrops (Kinzer and Gunn). J. Meteor. V. 8, 71–83, Apr. 1951.

Cloud Modification Experiments (Coons and Gunn). Compendium of Meteorology, Amer. Meteor. Soc., 235–241, 1951.

Precipitation Electricity (Gunn). Compendium of Meteorology, Amer. Meteor. Soc., 128–135, 1951.

1952

A Vertical Shaft for the Production of Thick Artificial Clouds and the Study of Precipitation Mechanisms (Gunn). J. Applied Phys., V. 23, 1–5, Jan. 1952.

An Analysis of the Results of the 1951 Cloud Seeding Operations in Central Arizona (Brier and Enger). Bull. Amer. Meteor. Soc., V. 33, 208–210, May 1952.

Continuous Generation of a Cloud for Laboratory Investigations (Phillips and Woessner), J. Meteor., V. 9, 370–373, Oct. 1952.

Some Evaluations on Artificial Rainmaking (Elliston). Paper presented at a meeting of the Columbia Basin Inter-Agency Committee, Oct. 8, 1952, at Yakima, Washington.

The Electrification of Cloud Droplets in Nonprecipitating Cumuli (Gunn). J. Meteor., V. 9, 397–402, Dec. 1952.

The Electrification of Small Air Bubbles in Water (Whybrew, Kinzer, and Gunn). J. Geophys. Res., V. 57, 459–471, Dec. 1952.

Status of Possibilities of Artificial Precipitation (Hall). Trans. A. G. U., V. 33, 866–870, Dec. 1952.

1953

Cloud Seeding Operations in the Bishop Creek, California, Watershed (Hall, Henderson, and Cundiff). Research Paper No. 36, U. S. Weather Bureau, 1953. Summary published in Bull. Amer. Meteor, Soc, V. 34, Mar. 1953.

Measurements of the Electricity Carried by Precipitation (Gunn). Chap. Viii, Thunderstorm Electricity, edited by H. R. Byers, Chicago University Press, 1953.

Comments on the Practicability of Cloud Seeding and Its Evaluation as a Method of Increasiug Precipitation (Vernon). Paper presented at Rainmaking Conference of the Central Valley Empire Association, Bakersfield, Calif., March 21, 1953.

Rainmaking—The Present Outlook (Hall). Paper presented at the 1953 Conference on Banking, April 10, 1953, at the State College of Washington, Pullman, Washington.

Raindrop Charge and Electric Fields in Active Thunderstorms (Gunn and Devin). J. Meteor., V. 10, 279–284, Aug. 1953.

Weather Modification (Vernon). Presented at the Hail Conference of the National Convention of the National Association of Mutual Insurance Underwriters, Oct. 12, 1953, in San Francisco, Calif.

1954

Artificial Inducement of Precipitation with Special Reference to the Arid and Semi-Arid Regions of the World. World Meteorological Organization Tech. Note No. 1 Secretariat of the WMO, Geneva, Switzerland, 1954 (assistance in study provided by USWB staff).

The Weather Bureau ACN Project (Hall). Presented at a meeting of the Columbia Basin Inter-Agency Committee at Portland, Oregon, Feb. 10, 1954.

Electric Field Regeneration in Thunderstorms (Gunn). J. Meteor., V. 11, 130–138, April 1954.

A 3000 Cubic Meter Cloud Chamber (Gunn and Allee). Bull. Amer. Meteor. Soc., V. 35, 180–181, Apr. 1954.

Diffusion Charging of Atmospheric Droplets by Ions and the Resulting Combination Coefficients (Gunn). J. Meteor., V. 11, 339–347, Oct. 1954.

Measurements of the Electrification of Spheres by Moving Ionized Air (Phillips and Gunn). J. Meteor., V. 11, 348–351, Oct. 1954.

7-Day Periodicities in May 1952 (Brier). Bull. Amer. Meteor. Soc., V. 35, Mar. 1954.

1955

The Weather Bureau ACN Project (Hall). Preliminary report presented at the 135th national meeting of the American Meteorological Society at New York, Jan. 24, 1955.

An Evaluation of the Results of Cloud Seeding in Western New Mexico and Southeastern Arizona During July and August 1951 and 1952 (Buell). Bull. Amer. Meteor. Soc., V. 36, 6–15, Jan. 1955.

Statistical Electrification of Aerosols by Ionic Diffusion (Gunn). J. Colloid Sci., V. 10, 107–119, Feb. 1955.

Systematic Electrification of Mist and Light Rain in the Lower Atmosphere (Gunn). J. Geophys. Res., V. 60, 23–27, Mar. 1955.

Systematic Electrification of Precipitation by Ionic Diffusion (Gunn). Proc. of Conference on Atmos. Elec., GRD Res. Paper No. 42, 232–236, 1955.

Net Electrification of Natural Cloud Droplets at the Earth's Surface (Webb and Gunn). J. Meteor., V. 12, 211–214, June 1955.

Seven-Day Periodicities in Certain Meteorological Parameters During the Period 1899–1951 (Brier). Bull. Amer. Meteor. Soc., V. 36, 265–277, June 1955.

Report on Classification of Storms for Statistical Evaluation with Special Reference to Carrizo Plain and Santa Maria Coastal Areas. (Vernon). Weather Modification Operations in California, Bulletin No. 16, State Water Resources Board, June 1955.

Artificial Control of Clouds and Hydrometeors. World Meteorological Organization, Tech. Note No. 13; Secretariat of the WMO, Geneva, Switzerland, 1955 (includes contribution by USWB).

An Experimental Analysis of the Effect of Air Pollution on the Conductivity and Ion Balance of the Atmosphere (Phillips, Allee, Pales, and Woessner.) J. Geophys. Res., V. 60, 289–296, Sept. 1955.

Droplet Electrification Processes and Coagulation in Stable and Unstable Clouds (Gunn). J. Meteor., V. 12, 511–518, Dec. 1955.

Raindrop Electrification by the Association of Randomly Charged Cloud Droplets (Gunn). J. Meteor., V. 12, 562–568, Dec. 1955.

The Weather Bureau ACN project (Hall). Final report covering the statistical phases of the evaluation submitted for publication as a monograph of the American Meteorological Society, publication pending.

1956

Storm Structure in Pacific Coast Cyclones (Hall). Presented at the 143d national meeting of the American Meteorological Society, New York, Jan. 23, 1956.

Initial Electrification Processes in Thunderstorms (Gunn). J. Meteor., V. 13, 21–29, Feb. 1956.

Some Conclusions From Field Tests and Studies of Cloud Seeding (Reichelderfer). Proceedings of the Conference on the Scientific Basis of Weather Modification Studies, April 10–12, 1956, Institute of Atmospheric Physics, University of Arizona, Tucson.

An Appraisal of Some Statistical Results From Weather Modification Studies (Brier). Proceedings of the Conference on the Scientifis Basis of Weather

Modification Studies, April 10–12, 1956, Institute of Atmospheric Physics, University of Arizona, Tucson.

Cloud-Seeding Potential in Middle-Latitude Cyclones (Hall). Proceedings of the Conference on the Scientific Basis of Weather Modification Studies, Apr. 10–12, 1956, Institute of Atmospheric Physics, University of Arizona, Tucson.

Some Problems in Utilizing Water Resources of the Air (Brier). The Future of Arid Lands, Pub. No. 43 of the Amer. Assoc. for the Advancement of Sci., 1956.

The Hyperelectrification of Raindrops by Atmospheric Electric Fields (Gunn). J. Meteor., V. 13, 283–288, June 1956.

Measurements Related to the Fundamental Processes of Aeorosol Electrification (Woessner and Gunn). J. Colloid Sci., V. 11, 69–76, 1956.

Electric Field Intensity at the Ground Under Active Thunderstorm and Tornadoes (Gunn). J. Meteor., V. 13, 269–273, June 1956.

Basic Physics of Atmospheric Processes (Gunn). J. Geophys. Res., V. 61, 359–362, 1956.

Measurements of the Systematic Electrification of Aerosols (Gunn and Woessner). J. Colloid Sci., V. 11, 254–259, 1956.

Laboratory Measurements of the Growth and Collection Efficiency of Raindrops (Kinzer and Cobb). J. Meteor., V. 13, 295–301, June 1956.

The Ratio of the Positive and Negative Light Ion Conductives Within a Neutral Cloud (Gunn). J. Colloid Sci., V. 11, 661–696, 1956.

Cloud Systems and Precipitation Processes in Pacific Coast Storms (Hoecker). Monthly Weather Review, V. 84, 421–426, Dec. 1956.

1957

An Experimental Investigation of the Effect of Air Pollution on the Initiation of Rain (Gunn and Phillips). J. Meteor., V. 14, 000–000. 1957 (publication pending).

Some remarks on the Status and Results of Cloud Modification Research (Kline). Presented at a meeting of the Missouri Basin Inter-Agency Committee at St. Joseph, Missouri, March 20, 1957.

Dr. REICHELDERFER. That concludes my prepared statement. Since in the days following the completion of this statement some time ago I have had a number of discussions with the Chairman of the Advisory Committee on Weather Control, Captain Orville——

Senator YARBOROUGH. Dr. Reichelderfer, do you have an additional statement on that?

Dr. REICHELDERFER. I do have——

Senator YARBOROUGH. A joint statement?

Dr. REICHELDERFER. I do have. Would you like to have it at this time?

Senator SCHOEPPEL. I think it should go into the record.

Senator CASE. I think this is probably the most significant statement we will have. I think it should be read.

Senator YARBOROUGH. We are considering what time we should recess. We originally planned to recess at 12:10, the Senate now being in session.

Senator SCHOEPPEL. Might I inquire of you, Doctor, it was originally announced that we would recess until 2 o'clock. I think if we run it a little later that we should recess until 2:30.

Senator YARBOROUGH. If it is satisfactory to the committee, then we will ask Dr. Reichelderfer to finish his statement and then recess until 2:30.

Senator SCHOEPPEL. Yes.

Senator YARBOROUGH. Will you proceed?

Dr. REICHELDERFER. In presenting this statement, I should say I am presenting it as Chief of the Weather Bureau. Captain Orville

is here. I would be glad to have him read the statement. I understand the plan was for me to proceed with it, if that is the desire of the committee.

JOINT STATEMENT BY DR. REICHELDERFER, CHIEF OF WEATHER BUREAU, ON BEHALF OF THE COMMERCE DEPARTMENT, AND CAPTAIN ORVILLE, CHAIRMAN, ON BEHALF OF THE ADVISORY COMMITTEE ON WEATHER CONTROL ON S. 86

We have in mind paragraph 9 of the statement on the status of weather modification just issued by the American Meterological Society, which reads:

"9. All cloud-seeding operations should be considered as experiments since the techniques are still under development and there is no sound basis for the quantitative estimation of the results in advance of the operation. As experiments, they should be designed primarily to yield optimum scientific results. There is good reason to believe that improved returns from cloud seeding will result from a sound experimental approach and this should be fostered by all concerned."

Without commenting upon the details of the bill or the Bureau of the Budget's policy on S. 86, it appears that any legislation on the subject of a long-range research program in the field of weather modification ought to contain the following elements:

1. There ought to be great emphasis placed upon basic research. Equally, it is recognized that we have come to the point in this field where applied research becomes increasingly important.

2. In view of the need for this double-pronged approach to research in weather modification, it is our belief that the basic research portion of the program should be under the direction of the National Science Foundation. On the other hand the applied research portion of the program should be directed by one of the permanent operating agencies of Government having principally in mind the Department of Agriculture, Commerce, or Interior. In this connection, it should be emphasized that good administration of the overall program demands that responsibility be placed in one official or office of Government. It would appear that the best place for such responsibility would be in the office of the Secretary of one of the aforementioned permanent operating agencies of Government.

3. With respect to the problem of defining the terms "basic" and "applied" research for the purposes of a long-range weather modification research program, we on the Advisory Committee on Weather Control would be most happy to provide the committee with working definitions of these terms in order that a practicable program of basic and applied research can be carried out by the respective agencies. In general, basic research deals with studies and investigations directed primarily toward development of meteorological theory while applied research refers to experimentation primarily for development of practical applications.

Dr. REICHELDERFER. If I may add one statement: It is my understanding that basic research as used in this statement would include both laboratory research and field experimentation of the kind that was conducted in the thunderstorm project which was really basic research, several years ago.

Thank you, Mr. Chairman.

Senator YARBOROUGH. Any questions?

Senator SCHOEPPEL. I have no quettions.

Senator YARBOROUGH. Senator Case.

Senator CASE. Has this statement that you have just read been cleared with the Bureau of the Budget?

Dr. REICHELDERFER. It has been.

Senator CASE. Mr. Chairman, I wanted to bring that out because I think to a large extent this represents a modification of the letters which have been previously placed in the record, if this is now presented as a joint statement by Dr. Reichelderfer on behalf of the Commerce Department and Captain Orville as Chairman of the Advisory Committee and is being presented with budget clearance,

to that extent it represents modification of the letter is in the record from the Bureau of the Budget and the Department of Commerce.

Dr. REICHELDERFER. This clearance was by word of mouth and, of course, I cannot speak for the Bureau of the Budget, but I was told definitely that it was cleared for presentation. However, I am not authorized to modify the letters stating the positions of the Department of Commerce of the Bureau of the Budget.

Senator YARBOROUGH. Those are the letters of May 10 from the Department of Commerce and the letter of March 5 to the Advisory Committee on Weather Control you refer to, Senator Case?

Senator CASE. Yes.

Senator YARBOROUGH. Are there any further questions?

Senator SCHOEPPEL. No further questions here, thank you.

Senator YARBOROUGH. You are excused, Dr. Reichelderfer.

(Communications to Senator Alan Bible, chairman of the subcommittee, are as follows:)

HYGROTROL CORP.,
San Francisco, Calif., May 7, 1957.

Re your letter of April 18, 1957.

Hon. ALAN BIBLE,
Subcommittee Chairman, Special Subcommittee (S. 86),
Senate Interstate and Foreign Commerce Committee,
Senate Office Building, Washington, D. C.

DEAR SENATOR: Enclosed please find letter of this date containing statement mentioned in your letter of April 18, 1957.

Fifty copies of this enclosed letter-statement are being sent under separate cover for your subcommittee's convenience.

Since it will be impossible for Hygrotrol to have a representative present at your May 13 hearing to make oral presentation of our statement, it was felt that a written statement rendered through the mails would be acceptable for the record.

It is sincerely hoped that through the result of your subcommittee's interest in development of weather control principles the benefit of Hygrotrol's efforts over the years in this field of endeavor may be made available to all.

Very sincerely yours,

C. ROSS PLEASANTS, *President.*

HYGROTROL CORP.,
San Francisco, Calif., May 7, 1957.

Re your letter of April 18, 1957, requesting statement.

Hon. ALAN BIBLE,
Subcommittee Chairman, Special Subcommittee (S. 86),
Senate Interstate and Foreign Commerce Committee,
United States Senate, Washington, D. C.

DEAR SENATOR: In conjunction with my previous letter of March 23, 1957, I request that the following statement, and enclosures, be entered for the record of your hearings:

After more than a quarter of a century of vainly trying to gain official recognition and acceptance of the practicability of weather-control applications I wish to say that it is indeed most gratifying to one such as myself, having weathered a score and more of years of disbelief from the incredulous, that the views and findings so costly acquired may now, at long last, be presented for the unbiased, thoughtful consideration of your esteemed body.

The method of cloud modification here discussed, and which, for a better clarification, I would prefer to define as a method of atmospheric conditioning, are in fact two separate and distinctive forms of application.

The first embodies the conventional method universally used, that of dispersing into the atmosphere a haloid compound to act as a nucleating agent for condensation of the water vapor in the air; which method, incidentally, is covered in United States Patent No. 2,160,900, issued to the writer, Clellan Ross Pleasants, and applied for on April 23, 1934.

The second method of application, a revolutionary new approach to the art of weather control, developed and owned exclusively by the Hygrotrol Corp.,

embodies an unusually unique, and heretofore unexplored, property of the atmosphere; causing normally occurring particles in the air to act, under the influence of Hygrotrol, as condensation nuclei.

Though my interest herein lies primarily in the conveying, to your satisfaction, of the desirability of the adoption of this latter atmospheric conditioning principle, the Hygrotrol process, a brief synopsis on my earlier experience with the former method may be helpful at this point.

This former method of atmospheric conditioning, that is, the releasing of a haloid compound nucleating agent into the atmosphere, was applied principally toward the clearing of fog from fogbound airports and/or airways. Its success in this application can be judged from the following newspaper and magazine headlined stories, copies of which are available for verification:

1. Los Angeles Examiner, June 7, 1936: "Miss Earhart Tests Aerial Fog Destroyer. Tests Successful."
2. San Francisco Examiner, September 30, 1936: "Victory for Inventor. Machine Dispels Fog. Bay Test Successful."
3. Oakland Post-Enquirer, March 16, 1937: "Amelia To Try Out 'Fog Eliminator' on World Flight. Invention of S. F. Man To Be Tested."
4. San Francisco Examiner, October 27, 1938: "Plane Dispels Fog in San Francisco Experiment. Huge Hole Cut in Mist by Chemicals."
5. San Francisco Chronicle, October 15, 1945: "A San Francisco Inventor Has a Sure-Fire Gadget—It Shoos Away the Fog."
6. Press-Telegram and Long Beach Sun, December 9, 1945: "Fog Cleared From Local Field by New Method; Plane Takes Off, Another Lands in Clearing."
7. Newsweek, December 24, 1945; Aviation News, January 21, 1946; Popular Mechanics, January 1946; Western Flying, February 1946; Flying Magazine, March 1946; Airworld, May 1946; True, April 1947; Coronet, June 1947; Popular Science, December 1947.

It was felt that acceptance of this method could be most readily attained through its application as a "fog dissipator," thereby demonstrating the practicability and actuality of a method of weather control. It was further felt that once this goal had been achieved, it would be much easier to apply the application to the art of "cloud modification" or, more popularly, "rainmaking." This change over from "fog dissipating" to "rainmaking" being merely a matter of proper meteorological engineering.

As is well known, since mid-1947 this method of atmospheric conditioning, that of dispersing a haloid compound into the atmosphere to act as a nucleating-agent for the condensation of water vapor in the air and thus increasing rainfall, has likewise proven successful. It should be noted that these rainmaking operations were predated more than 15 years by my own personally conducted fog-dissipating operations; and which fog-dissipating operations were, as indicated herebefore, highly complimented by numerous prominent personages, including the late Amelia Earhart.

Just as in my demonstration of the fog-dissipating qualities of the above method, of releasing a haloid compound into the atmosphere to affect the clearing, so it was in the case in connection with development of the latter described atmospheric conditioning method and the one most important in this communication; the Hygrotrol process.

Here again it was felt the most readily applicable use of the method would be in the field of fog eradication from airports and airways, and for increasing visibilities in general.

As in the earlier method, the Hygrotrol application proved extremely efficient; considering its being in its infant stage of development. In our initial test operation, conducted at the Sacramento Municipal Airport, Sacramento, Calif., during the winter months of November, December 1948, and January 1949, there occurred a 157 percent of average increase in time the field was open to CAA flight conditions. This period of time was chosen for the test because it is the period during which Sacramento suffers the greatest number of "closed" hours because of fog. This startling improvement proved typical of all Hygrotrol operations or demonstrations since; as exemplified by the following headlined press releases:

1. San Mateo Times, September 22, 1950: "Invention Clears Away Fog Area in Colma."
2. Daly City Record, September 28, 1950: "New Invention Promises to Eliminate Fog Belts."
3. San Francisco Examiner, September 21, 1951: "* * * C. R. Pleasants, an inventor who lives on Twin Peaks, * * * has invented a fog-dispelling machine that really works."

Coincidental with the observation of increased visibilities during Hygrotol operations, there was also noted, as was to be expected, an increase in precipitation over a rather broad, extensive area from the point of operation. I say this was to be expected because it was the theory that in reducing foginess, or otherwise by increasing surface visibilities, such surface moisture and contaminants in the air would be raised to higher elevations. If these upper atmospheric levels to which the moisture and contaminants were so raised happened to be near the point of saturation, then it was within reason to assume that such added moisture would be sufficient to cause a condition of supersaturation and possibly, if conditions were right, precipitation.

On the other hand, if these upper atmospheric levels were not as yet at the point of saturation, it could be assumed that the raised moisture would be carried away from above the point of operation by the prevailing winds at those elevations and precipitation would not take place until a condition favoring supersaturation had been encountered; such as when the air mass involved was forced by topographical contours of the earth below to raise over a mountain or similar surface obstacle.

In this regard, during the Sacramento Airport test and a later extended test of Hygrotrol at the San Jose Airport, San Jose, Calif., as well as elsewhere, unusually heavy precipitation occurred over the Sierra Nevada, and over the States of Nevada and Utah. Also, wherever Hygrotrol operated, and where meteorological conditions favored same, precipitation locally was noted to be unusually heavy.

It was also observed that the heaviest precipitation occurred when cloud-seeding tests were being conducted at the same time that Hygrotrol tests were underway. When Hygrotrol ceased its operations, though silver-iodide cloud-seeding operations were still in progress, it was found that, invariably, the precipitation that had been heavy, declined markedly. Conversely, when Hygrotrol continued operating, though cloud-seeding tests had ceased, there was a much less decrease in the amount of precipitation occurring.

This effect is believed due to the apparent Hygrotrol effect of increasing surface evaporation. Coincidental to this has been the constant observation of increased vegetative growth in the vicinity of Hygrotrol operations.

From these observations it can be deduced that Hygrotrol would be an all important and mandatory adjuvant to the so far demonstrated to be less reliable haloid compound cloud-seeding technique of atmospheric conditioning.

As can be seen, with proper meteorological coordinate engineering of either or both methods, any desired weather condition would be within the realm of possibility by correct manipulation of the process used; proving a most desirable solution to that double-edged climatic sword, the dreaded, costly drought-flood cycle. And, as well, in view of the warning by the late, renowned Dr. John Von Neumann that "Warfare by climate control could be more devastating than warfare by nuclear weapons"—it is most urgent that this control be developed at the earliest date.

If it should be asked why, despite my many proven successes over the past three decades, these successful weather-modification demonstrations have not achieved the official recognition so earnestly sought, I can only refer to the countless similar apathetic reactions throughout the history of mankind by contemporary critics to newly discovered applications of natural phenomena.

And if I may be permitted to add a personal comment in closing; it is, as Miss Earhart confided to me prior to her fatal departure, that she would have the honor of being actively associated with and in some small way responsible for the recognition of weather-control principles. That a duly authorized body of the United States Senate would have occasion to hold such hearings heralding this official recognition at the approach of the 20th anniversary of Amelia Earhart's unfortunate disappearance, must, indeed, be providential.

Very sincerely,

C. Ross Pleasants,
President, Hygrotrol Corp.

Hygrotrol Corp.,
San Francisco, Calif.

HYGROTROL

(Meaning: Control of atmospheric moisture)

Hygrotrol is the name applied to a specially compounded battery which, when electrically excited, affects the meteorological pattern through the apparent

release of the latent heat of the water vapor in the atmosphere to the surrounding and adjacent air molecules.

It is almost impossible to give a short demonstration of this method of hygrometrical control that is entirely convincing because the primary action is a trigger action. The visible effects are all results of chain reactions. The multiplicity of the links in all of these chain reactions depend upon the sum total of all meteorological conditions and factors over a vast area, and are multiplied and complicated still further by the fact that these conditions are forever changing and are in constant motion.

The immediate reactions to the trigger action vary within an almost infinite number of possible different visible effects and are very often totally invisible. The principal immediate reaction is a slow atmospheric rise which draws the surrounding air and moisture upward to the center of the rise, which is to the lee of the wind and relative to its velocity. This rise causes expansion and, consequently, either condensation or lowered relative humidity, in which case any previous condensation is revaporized and carried away.

In heavy weather, condensation not revaporized because of saturation of the air falls to the ground as drizzle or remains as fog or clouds, all depending upon what other meteorological factors are present. The desired net reaction result is to cause the condensation to fall to the ground, or to remain as clouds, or to become and remain revaporized, or a combination of all three of these conditions, but without fog or low ceilings. This is the usual result. This net reaction result occurs sometimes almost immediately, but usually several hours after commencement of initial operations of the "battery."

The successful engineering of the process consists of using the trigger action only at the times that the best advantage can be taken of all ensuing meteorological reaction factors, in order that the net reaction result will be the result desired. For this reason, a completely convincing test would have to be a set goal maintained over a reasonable length of time.

Closed conditions at Sacramento Airport (average number of hours, and time)

DURING AN 8-YEAR PERIOD (1940-41 TO 1947-48)

	Average Number of hours closed were—	Average time closed (percent)
November	51	7.00
December	125	17.30
January	126	16.93
Season	302	13.67

DURING THE HYGROTROL OPERATION (1948-49)

November	6	0.80
December	[1] 105	14.70
January	17	2.40
Season	128	5.80

IMPROVEMENT OF FLIGHT CONDITIONS WHILE HYGROTROL WAS IN OPERATION

	Improvement in hours open	Decrease in time closed (percent)
November	45	90.00
December	20	16.00
January	109	85.00
Season	174	57.00

[1] In December, a test of the value of Hygrotrol dispersal qualities compared to preventive qualities, per unit, accounts for the Hygrotrol results for December being out of all proportion to the rest of the season.

HOURS CLOSED AT SACRAMENTO AIRPORT DUE TO SUBMINIMUM CAA WEATHER CONDITIONS

The following is a breakdown of the total number of hours that the Sacramento Airport was closed, because of subminimum CAA weather conditions during the fog season, November, December, and January, of the yearly seasons inclusive, from 1940–41 to 1947–48.

An average of the hours and percentages of time closed during the fog seasons of 1940–41 to 1947–48 is compared with the hours and percentages of time closed during the fog season 1948–49, at which time the Hygrotrol equipment was in operation at the Sacramento Airport.

Hours closed to all flight because of subminimum weather conditions at Sacramento Airport, Sacramento, Calif.

Season	November	December	January	Total for season
1940–41	44	48	105	197
1941–42	101	78	149	328
1942–43	26	201	137	364
1943–44	38	77	33	148
1944–45	62	180	171	413
1945–46	31	88	127	246
1946–47	64	170	217	451
1947–48	42	160	71	273
Total	408	1,002	1,010	2,420
Average	51	125	126	302
During Hygrotrol operation: 1948–49	6	105	17	128

The figures, up to and including the fog season of 1943–44, were taken from Percentage Frequencies of Closed Weather, Classified Flying Weather for the United States, published by the Weather Bureau, under the United States Department of Commerce. The figures for the other fog seasons were taken directly from the daily weather reports of the Sacramento Airport.

The figures show very clearly that flying conditions during the Hygrotrol period of operation were greatly improved, not only above the average of all the seasons, but, as well, over the season of best flying conditions on record. That season, 1943–44, the seasonal rainfall, up to the end of December, was only 2 inches as compared to 8 inches for the season 1948–49. Records show that Sacramento's fog season is usually in direct proportion to its rainfall; the heavier the rainfall, the more intense the fog condition. This rule did not apply during the Hygrotrol period of operation.

FLORIDA FRUIT & VEGETABLE ASSOCIATION,
Orlando, Fla.

Hon. ALAN BIBLE,
Chairman, Weather Modification Subcommittee of the Interstate and Foreign Commerce Committee, United States Senate, Washington, D. C.

DEAR SIR: Our association recently received notice that your subcommittee would hold public hearings May 13, 1957, on Senate bill 86, regarding the establishment of an experimental program in cloud modification.

The Florida Fruit & Vegetable Association, 4401 East Colonial Drive, Orlando, Fla., a trade association representing more than a majority of the vegetable and subtropical fruitgrowers in Florida, would appreciate the enclosed statement being made a part of the public record concerning this bill.

Respectfully yours,

(Signed) JOFFRE C. DAVID,
Secretary-Treasurer.

A Statement of the Views of the Vegetable Industry of Florida to the Interstate Commerce Subcommittee During Public Hearings on Senate Bill 86 Providing for an Experimental Research Program in Cloud Modification

Made by the Florida Fruit and Vegetable Association, Orlando, Fla.

The vegetable industry of Florida recently has experienced a situation that shall commonly be associated with any attempts by man to modify rainfall or weather. A program was established by segments of the citrus industry of Florida to increase the amount of rainfall due to a severe shortage of water throughout the State. The possibility of such rainfall occurring during the harvest period for tomatoes caused a confliction with the best interests of the Florida tomato industry. This resulted in considerable disagreement between the two industries on the operation and advisability of this rain-making program.

It should, therefore, be recognized by this committee that wide differences exist in the need and benefits of rainfall on agricultural crops in a given area at a particular time. It is a well known fact that an adequate supply of moisture is essential for plant growth; yet, rainfall at the wrong time may adversely affect a crop by causing reduced yields, loss of quality and perhaps, total loss. For example, tomatoes receiving rains during the harvest period will develop growth cracks and loss of quality, while citrus crops in the same general locality, and at the same time may require rainfall.

For the many varied and complicated situations that exist and will occur over the Nation, some legislative control should be placed over the Federal Government attempting to conduct unregulated experiments on weather modification. All parties concerned within an area subjected to weather modification experiments should be agreeable to the value and suitable of the experiments prior to their commencement. This safeguard may be accomplished either through public hearings or some type of arbitration board.

The Legislature of the State of Florida is presently in the process of regulating all weather modification programs by providing for the licensing, control and regulation of such operations by the State board of conservation, while at the same time, prescribing certain penalties for any violation. Any experimental research program established by the Federal Government should incorporate similar protective features within its administration and operation.

Such experimental programs involving weather should be integrated within the functions of the United States Weather Bureau, rather than the establishment of a new authority or agency, separate and apart from the control and supervision of the Weather Bureau. The Weather Bureau has the personnel and experience to best conduct and organize any experiments on weather modification, if furnished sufficient funds. The creation of any new agency authorized to bypass the Weather Bureau can only result in complications, duplications, and in efficiency.

The creation of an advisory committee on this subject is advisable, but it should not be authorized to direct and formulate a program of experimental research in the field of cloud modification, separate and apart from this existing governmental agency.

The membership of the Florida Fruit & Vegetable Association approves and encourages additional investigations and study in the field of weather modification, but it urges that administrative procedures be established whereby the best interests of all individuals may be protected. Any Federal legislation should contain explicit and definite safeguard features in order that the interests of all parties are considered and protected before any program of weather modification is conducted in a particular area.

American Meteorological Society,
Boston, Mass., May 9, 1957.

Hon. Alan Bible,
United States Senate,
Washington, D. C.

Dear Senator Bible: I regret very much that I will not be able to accept your kind invitation to appear and offer testimony at the public hearing on S. 86.

You may be interested in the enclosed statement approved for release by the Council of the American Meteorological Society which states the position of this society on weather modification.

As far as my personal opinion is concerned, I subscribe completely to the statement prepared by the society and particularly to paragraph 9 of that statement. I do feel that if the bill is passed it will be fruitful only if a constructive, forward-looking research program is put into effect.

Sincerely yours,

THOMAS F. MALONE, *Secretary.*

The statement of the American Meteorological Society referred to in the above letter appears as part of the Statement of the Honorable Arthur V. Watkins on page 113.

Senator YARBOROUGH. The committee will stand recessed until 2:30 this afternoon.

(Whereupon, at 12:36 p. m., the subcommittee recessed until 2:30 p. m., the same day.)

AFTERNOON SESSION

Senator YARBOROUGH. The hearings will be resumed on Senate bill 86.

The first witness is Dr. Alan T. Waterman, Director of the National Science Foundation.

STATEMENT OF ALAN T. WATERMAN, DIRECTOR, NATIONAL SCIENCE FOUNDATION

Dr. WATERMAN. Mr. Chairman, I have a prepared statement if you would care to have me read that, and submit it to the clerk of the committee.

Senator YARBOROUGH. You may present your testimony in whatever fashion you choose. The committee is here to obtain information on this subject, so important to the American people, and if you do not care to make a statement, you may file your written statement, and it will be placed in the record.

If you desire to present it orally for the benefit of the committee and of the other witnesses here who are to follow you, with any comments they might care to make, present it in that manner, whichever manner you prefer.

Dr. WATERMAN. I shall choose the latter, Mr. Chairman, if it is all right with you and read the statement.

Senator YARBOROUGH. You may proceed.

Dr. WATERMAN. Mr. Chairman, and members of the committee, I am very happy to appear before you today, and set forth my views regarding S. 86, a bill to provide for an experimental research in cloud modification.

I might add that, of course, all of us familiar with the situation have great sympathy for the States affected by drought conditions, and realize the very great importance of anything that science can do to remedy the drought situation and to have the opportunity of ameliorating the situation by an increase in normal rainfall where that is possible.

I am sure that we are all anxious to do what we can in science to help out in that respect.

I am familiar with the problems involved here, not only as Director of the National Science Foundation, but also as a member of the Ad-

visory Committee on Weather Control. From the excellent evaluation activities of the staff of the advisory committee, evidence to date seems clearly to indicate that no large or important rain-producing effects will be achieved by present means without further research to acquire a better understanding of the process by which nature produces precipitation of rain or snow.

Furthermore, positive effects insofar as we can find out at present only occur in special meteorological situations and others badly need to be explored.

It is my view, then, both from the studies of the committee and from consideration given to the subject in the foundation, that by far the most important element toward effective progress in weather modification at this time lies in a planned program in support of research by competent scientists on the fundamental problems dealing with the precipitation progress.

In that I am in agreement with the other speakers you have heard today; such studies should be conducted through planned field experiments in both basic and applied research, as well as under controlled laboratory conditions. Such field experiments may consist of studies into the conditions under which precipitation occurs naturally and also of studies to determine the factors involved in the effects of man-made attempts to duplicate or augment natural processes. Plans for the latter type of field experiment should include authoritative means for statistical analysis and evaluation which is a difficult task.

In order to achieve maximum effect in causing or encouraging the precipitation of water vapor into rain or snow, scientists are generally agreed as to the fundamental requirements to be met since what man can do is almost insignificant compared to the massive scale on which nature operates.

The most promising attempt for a large and important effect, would be to try to locate some critical point and time where nature's forces are in balance and undecided, so to speak, whether to produce rain or not, or whether the rain is to increase or decrease. Then the small nudge which man may make might swing the balance his way.

The same is true of any other large-scale phenomena that we might try to influence, such as fires, floods, epidemics, or wars. If we can get started at the right time and place, then we can produce a major effect.

Another method is to try to devise a chain reaction which will propagate itself and spread rapidly over a large area. This is true in limited fashion in the use of carbon dioxide snow, as discovered by Langmuir and Schaefer. But this is confined, as weather people know, to a particular type of cloud formation and very special conditions of temperature. When these conditions are found there is not apt to be much moisture present for practical purposes.

The method which has been widely tried over the past few years, the use of silver iodide or similar agents, does not appear to produce a chain reaction but only attempts to provide nuclei available for moisture to condense upon.

Whether it is successful or not obviously will depend upon whether the condensation into water at that particular spot requires additional nuclei or not, and whether the conditions are such that the condensed moisture will form drops large enough to fall as rain. We do not yet

know the nature or the optimum number of nuclei nature needs for precipitation purposes and therefore, if we provide nature with additional nuclei we do not know whether this will aid or hinder rain formation.

By this testimony I do not wish to seem unduly pessimistic. Research and experiment to date have shown promise that ultimately we may find a means of weather modification which, hopefully, may be of great practical importance; but evidence to date seems to indicate clearly that no large or important effects will be produced by present means until further basic research has led to great improvement in our understanding of this process and of the possible meteorological conditions which may promise more effective results.

For these reasons, I would strongly advocate that what is needed at this time is a systematic research program aimed at securing the answers we need. The problem is one of great difficulty and complexity and should be placed in the hands of only the most competent scientists and organized team of scientists we can find.

It would seem to us wise not to attempt to embark upon any program having as its aim the development of a means of weather modification with practical results, until we have some scientific assurance that such a means is practical and feasible. It would be even more unwise, in my opinion, to attempt field operations using present techniques in the hope of achieving results of practical importance until we are sure that there is good evidence that they may succeed. Such activities would be misleading, would undoubtedly lead to disappointments, and would in all probability involve a waste of money and effort. When one considers that we do not really know whether cloud seeding according to present methods will produce or inhibit rain from any cloud formations, it seems clearly in the public interest not to encourage such attempts.

Besides, there is always the distressing likelihood that a chance success might produce rain, not upon the area desired, but, upon some locality where it is not wanted.

Since the Advisory Committee on Weather Control has had these matters under careful consideration now for some years, its final report should be invaluable in formulating constructive plans for the future and in identifying promising avenues of research.

I would, therefore, recommend that, instead of the special program authorized by S. 86, the agencies of the Federal Government sponsoring research in this scientific area further encourage, stimulate, and support competent work in the sciences relating to this general subject. Only when our basic knowledge of the processes involved have advanced further, would it be desirable to enter into cooperative arrangements in needy areas for development and operational activities in this field. In the meantime the Advisory Committee on Weather Control should continue preparation of its final report which would include plans for future activities in this important area.

The National Science Foundation, as a Federal agency, has the authority and a definite interest in promoting basic research in the general area of weather modification both in the laboratory and in the field. It has already made a number of research grants in this scientific field, and intends to press for further effective research on

this general subject. The cooperation of other permanent agencies of the Federal Government would be sought by the Foundation in carrying out such plans for practical developments as might arise out of this fundamental research no matter where done.

It would, in my opinion, be more effective to have such a program, whether research, development when feasible, or both, administered by the permanent departments and agencies of the Federal Government, rather than by a temporary advisory committee which is not, and in my opinion should not be, organized to carry on an operating program.

The Bureau of the Budget has no objection to the submission of this report.

I shall be very glad to answer any questions.

Senator YARBOROUGH. Dr. Waterman, I note through your report your opinion of the inadvisability of embarking upon a program developing a means of weather modification and point out the necessity for research in the field first.

I was not a member of the subcommittee at the time of the March 26 hearing and could have missed some important testimony. However, it is my understanding that the purpose of S. 86 is to undertake a program of experimental research in both basic and applied research to determine whether or not cloud modification was feasible.

Am I mistaken in that?

Dr. WATERMAN. No, sir, that is my understanding. I wanted to emphasize the advisability of doing a thorough research job before development is started, because it is in development that the money begins to be large.

I think in the national interest, it is wise not to start development until the research points the way. But research, both basic and applied in the laboratory and in the field is very much in order.

Senator YARBOROUGH. I do not believe that I see in this bill a specific direction for the development of any program, any actual weather-control program, but rather it says a program of experimental research.

Dr. WATERMAN. Yes.

Senator YARBOROUGH. That is the authorization it is attempted to be set up under.

Dr. WATERMAN. As a second point related to that and perhaps to have in mind, Mr. Chairman, I believe at present research in this area is so difficult to accomplish and to evaluate that the research should be put in the hands of the most competent groups we can find, no matter where they may be. That is a first consideration.

Senator YARBOROUGH. I take it that you are in accord with the purposes of the bill in having research on this cloud modification.

Dr. WATERMAN. Yes, sir, very strongly.

Senator YARBOROUGH. You are not opposed to research on that problem.

Dr. WATERMAN. No, sir, by no means.

Senator YARBOROUGH. You are only in opposition, I take it, to the method set out by the Senate bill, S. 86, is that correct or not?

Dr. WATERMAN. Yes, sir.

There is another point, though, that if it is true that this is in a very difficult complicated stage, then one cannot count on valuable re-

turns from money going to States for the purpose of research unless those States have institutions or agencies that are quite competent in the field. It is the same question always found in research, if the problem is difficult you must put it in the most competent hands you can find.

Senator YARBOROUGH. Senator Schoeppel, have you any questions?

Senator SCHOEPPEL. I have no further questions at this time, I believe.

Senator YARBOROUGH. What do you think of the amount, Dr. Waterman, of money recommended in Senate bill 86, and the period of time over which it is to be spread, $5 million, to be spread over 5 years for research?

Dr. WATERMAN. That seems to be reasonable to me, sir.

The basic research which can be done in laboratories is often quite inexpensive. On the other hand, if extensive research facilities have to be built or research laboratories, this can be expensive.

The major expenses in such a research program would be field experiments, which can require fairly large sums. I think this amount would be a reasonable one over 5 years, sir.

Senator YARBOROUGH. You recommend in your statement that this research be done by a permanent department and agency of the Federal Government. In your opinion where could that best be done?

Dr. WATERMAN. I think that the agencies that support basic research in the field could very well carry out that research. We in the foundation can support basic research very easily, as we are now doing in this field. Any time that events take a turn toward developing a practical method, then that would rule out the National Science Foundation, because we do not have authority for support of development, nor do we wish it.

The other Government agencies have already been mentioned that have an interest in the subject, the Department of Commerce, Interior, and Agriculture, and they could very well carry on basic research, to the extent that they are authorized, and also any developmental work that might come up.

I think the most logical way of carrying this out, in principle, Mr. Chairman, would be to have some agency take charge of this in the spirit of the act, namely, to accept general supervision of research plans.

Such an agency should then have a steering committee available to the director of the program, composed of the most competent meteorologists that we can find, to determine the direction that the research should take, what basic problems should be explored, what applied research should be undertaken, etc. And in short, monitor the program and give the agency the benefit of its scientific advice.

Then the recommendation of this committee should form an agenda for an interagency committee of governmental agencies of the interested departments and offices of the Government.

In this way the agencies would be enabled to plan their own share of the program, this in a cooperative manner, and be sure that coordination would exist.

Senator YARBOROUGH. In reading the statements of several witnesses there seems to run through, not yours, but several others, this thread of thought: That certain types of cloud seeding are either

feasible or not feasible for cloud modification and modification of rainfall. It isn't expressed in that exact language, but that seems to be the trend of thought.

Let me ask you has research proceeded to the point that we could say that that method of cloud modification either would or would not succeed and that was it?

Isn't there a possibility that there might be other means of cloud modifications, not yet tested, perhaps not thought of, or if thought of, not even experimented on in the laboratories?

Dr. WATERMAN. I think any scientists would always admit that possibility, Mr. Chairman.

It certainly would be true here. I did not go into that sort of detail in my statement, but I believe it is generally felt—and I would agree—that the type of formation where moisture-laden air is lifted up over a mountain range is more likely to have the present technique succeed, than the kinds which we find in flat country. But much more work is needed to study other types of meteorological situations, other types of clouds. What we badly need to make a large improvement is a good understanding of how it is that a droplet forms in the air somewhere, how nature does it. What is the nature of the nucleus on which moisture condenses? We don't know that yet.

And how does additional moisture succeed in building the drop larger?

If we knew that, then we could begin to prescribe what we might do to duplicate nature's processes.

Senator YARBOROUGH. Research has not yet determined how it is formed in clouds?

Dr. WATERMAN. We don't understand that process at all thoroughly. That to me is the greatest problem, if we knew that, then we would be in a much stronger situation in going into nature, and trying to find out how nature does it.

Of course, at the time like this we want to do both, we want to understand how nature produces these things, in the natural process, and we want to do it under the microscope, so to speak, in the laboratory, so that we can prescribe better.

Senator YARBOROUGH. Do you concur in Dr. Schaefer's conclusion that at this time it seems more likely that success would tend to efforts to modify or alleviate the damage from tornadoes and thunderstorms and hail and lightning than from relieving from drought?

Do you think that man is closer on the trail of preventing lightning damage and preventing tornadoes than he is in solving the drought problem?

Dr. WATERMAN. That would be a very hard question to answer, Mr. Chairman. I think I would agree with Dr. Schaefer for this reason: That a drought condition extends over a large part of the country for a long time, that is, one where there just is no moisture anywhere near.

To try to provide moisture when none is present would seem like a pretty hopeless task. But to discover the situation whereby a tornado is generated, and try to change that situation, or the origin of a hurricane and see if it can be broken, or the same kind of thing with thunderstorms, would seem to be promising. It is still most difficult.

Senator SCHOEPPEL. I have one question here with reference to your letter of March 8, 1957, directed to Capt. Howard T. Orville, United States Navy, retired, as Chairman of the Advisory Committee on

Weather Control, the beginning of the fourth paragraph in your letter—you may recall it—you make this statement:

> Insofar as the National Science Foundation may be involved in future planning, it would be contrary to foundation policy to conduct or support a general plan in cooperation with the States or in any other manner aimed at development of practical means for weather modification, or in operational plans for proceeding toward this end.

And you say:

> In acordance with its established policy, however, the foundation would, if requested, consider taking the lead among Federal agencies in establishing and carrying out a research program for a better understanding of the subject.

I mention that because it has been drawn to my attention that it might be susceptible of some misunderstanding. Do you think that it is inconsistent with the position you have taken here?

Dr. WATERMAN. No; I think not. That letter to the chairman of the committee was in answer to a request as to what the National Science Foundation might do with respect to this problem. And our act gives us authority to support basic research—not to conduct it—in a variety of ways, and to conduct evaluations to determine policy. When it comes to the practical side, which I call development or operations, we not only are not authorized to do this, but would prefer as a policy not to.

So that the latter part of such a problem we would handle by making arrangements with another agency to carry on. I think that is consistent with my letter.

Senator SCHOEPPEL. I see. That clarifies it. I wanted to get that into the record in view of this letter.

Dr. WATERMAN. Yes, sir.

Senator SCHOEPPEL. I have no further questions, Senator Yarborough.

Senator YARBOROUGH. You may be excused, Dr. Waterman.

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
Washington, D. C., May 21, 1957.

Hon. ALAN BIBLE,
Chairman, Special Subcommittee of the Senate Interstate and Foreign Commerce Committee, United States Senate, Washington, D. C.

MY DEAR SENATOR: This letter relates to S. 86, a bill to provide for an experimental program in cloud modification.

My interest in the bill derives from my concern with meteorology, and from my hope that something positive be accomplished to alleviate the water shortage in the dry regions of our country. This interest is, in part, reflected in my membership in the Committee on Meteorology of the National Academy of Sciences-National Research Council, and in my being an alternate member, from the National Science Foundation, of the Advisory Committee on Weather Control. I was not present at the hearing on Monday, May 13, but on the basis of oral reports, I believe it appropriate to present or emphasize certain aspects of the matter that I am sure your committee will wish to consider in connection with S. 86.

The first point that calls for comment is that in February 1956 the Advisory Committee on Weather Control issued its first interim report, in which the Committee determined upon a termination date of June 30, 1958, and so recommended; and the Congress responded by extending its life to that date from June 30, 1956. In coming to this decision, the Committee felt certain that the 2-year extension would, with good planning and management, enable it to complete its assignment. It recognizes that it is an advisory, not an operating committee, and that there are existing agencies of Government that are qualified and authorized under the law to conduct and support experimental work in cloud physics, and to receive and use appropriations for the purpose. S. 86 would, in effect, extend the life

of the Advisory Committee for a number of years, and make it an operating committee. It is my belief, based on the report, the Committee does not desire this. It involves duplication of functions and additional administrative expense, and tends to perpetuate a temporary committee.

My second concern is this: The Committee in its first interim report repeatedly referred to the serious lack of our basic knowledge and emphasized the importance of a better understanding of atmospheric phenomena, so that the probability of success in practical efforts to increase (or otherwise control) precipitation might become greater.

The number of competent researchers in this field is extremely limited. For example, there are only about 10 universities in the United States that undertake to carry on training and research in meteorology. The supply of qualified scientists in this field should be increased so that experiments in cloud modification. to produce unequivocal results, may be done only by competent persons. There are exceedingly few of them at the colleges and universities in the arid States.

Under S. 86, the desperate need for more water in the dry areas could easily lead to poorly planned and hurriedly executed attempts at cloud seeding that would neither advance our knowledge of the science nor result in tangible benefits. On the contrary, it could lead to fruitless expenditure of a substantial part of the funds that might be appropriated under the authorization of the proposed law.

The third point to emphasize is that the areas of our country that are and have been dry throughout the years for which records are available have low rainfall because of their physiographical features and their patterns of atmospheric circulation. They are dry because the air passing over them is deficient in maisture; its relative humidity is generally very low. Most of the clouds that are formed appear to be so "dry" that very little water from them can reach the ground. Until a way might be found of bringing about the natural transport of more water by the air, and consequently clouds richer in water, there can be little hope of long-term increase, either natural or artificially induced, in average annual rainfall over the areas involved. That there are sporadic and occasional deviations from the average does not alter the facts of the general situation. However, on such rare occasions when, in a dry area, clouds appear that by competent judgment are a prospective source of rainfall in a particular area if seeded, it would be not merely justifiable but most desirable that seeding be done, from considerations of temporary local benefit if the operation were successful. Such seeding, however, would not be likely to contribute much to basic knowledge, nor could it readily be planned as part of a research and development program. For this reason, it would seem more logical, when there is a reasonable expectation of a positive result, that the seeding be undertaken as a local operation rather than as a research project.

It should be stressed that no fully acceptable, unbiased evidence exists that seeding of clouds results in appreciable increase in rain or snow over what would have fallen without seeding. One exception comes out of the careful study of data made by the scientific staff of the Advisory Committee on Weather Control, from which it could be deduced that in a fraction of the seeded storms that were analyzed, increases in actual above expected precipitation over the periods analyzed ranged from 7 to 19 percent. These were selected situations, during cold seasons, in mountainous areas where the topography caused an updraft of moisture-laden air. The results cannot be taken to imply that such results would follow in level terrain, or with warm clouds, where the conditions are so completely different.

My final point is that the Advisory Committee's interim report expresses findings that are rational and realistic with reference to the research, both basic and applied, that is needed. This must be done both in laboratories and in the field. In keeping with these findings, the National Science Foundation is already encouraging and supporting research in atmospheric physics, in both the laboratory and the field, and is cooperating with other Federal agencies to the end that research results may be quickly tested and applications developed. Moreover, it is in process of expanding its program in this field, with the advice of a competent panel of scientists now being established.

We must be under no illusions that modification of clouds, to achieve specific, planned results, can be accomplished in our present state of knowledge. Even with every resource that we can intelligently apply to the problem, its solution is not in sight. In the meantime, we must not allow efforts to increase the water supply in dry areas by any other promising methods to lag, in the expectation that cloud seeding will be the complete, reliable answer.

It would be my view, therefore, that your committee should determine, before recommending action on S. 86, whether the objectives of the bill could not be attained through existing, permanent agencies, without special authorization, rather than adding such responsibility to the present duties of the Advisory Committee on Weather Control.

Sincerely yours,

PAUL E. KLOPSTEG, *Associate Director.*

Senator YARBOROUGH. The next witness is Mr. Morrison Cunningham, of Oklahoma City, Okla.

STATEMENT OF MORRISON CUNNINGHAM, DIRECTOR OF PUBLIC WORKS, OKLAHOMA CITY, OKLA.

Mr. CUNNINGHAM. Mr. Chairman, gentlemen of the committee, my name is Morrison Cunningham, director of public works, city of Oklahoma City.

I filed more or less just a general statement, but I would rather make a verbal statement for the record, Mr. Chairman.

Senator YARBOROUGH. Please proceed.

Mr. CUNNINGHAM. My interest in this subject has been accumulating over a period of several years, especially beginning with the drought. I had occasion to enlarge my interest several years ago, when I served as president of the American Water Works Association, and have been active on the Advisory Committee on Pollution Control. That gave me an opportunity to observe rainfall deficiencies around the United States, and its effect on all water users.

In Oklahoma City, we have a shortage of municipal water, it started in 1952.

I was directed by our city officials to go into the matter of cloud seeding or weather modification. I made a rather extensive investigation to try to find the experience that they had had on a number of projects as well as to try to determine an organization that would more likely be in position to have the scientific knowledge, as well as the experience, that would be able to get results and an organization of that type then was selected.

We had very good results from the first project that we had, in 1953. We skipped a year on account of our supply being relatively filled. Then in 1955, as we were short of water again, we renewed the contract.

Last year, 1956, the river didn't have any flow in it for 16 months. This year, we have renewed our contract, this brings out a point that I would like to make, and that is we went into the question of long-range weather forecasting to determine what the weather was likely to be and the seeding opportunities. After all, if there were no seeding opportunities, then there is very little benefit from a project. We started getting forecasts in February 1957.

We got the forecasts which looked pretty good up through June. So, we entered into a contract and so far the results have been more than the report originally showed. In other words, the original forecast was really on the conservative side.

We feel that we definitely received benefits from cloud seeding even though this is in the plains area, Central Plains. And certainly, that part needs research. There seems to be some doubt as to just how effective cloud seeding is. Maybe it is less effective in that area. But we do feel though that there are certain storms, certain cloud

formations, certain moisture conditions which do contribute to a project of this kind, in weather modification.

At least, we have been amply paid, at least we have filled our reservoirs each time that we have had these contracts.

We have also carried on observations that may be of interest to you, since tornadoes have been mentioned. The target area covered by seeding operations are largely in the northwest part of Oklahoma. A number of storm warnings have been issued, but so far our observations and careful analysis of the reports that have been made, we have never had a tornado funnel touch the ground in the seeded area, where it was seeded in advance of the storm. Those are careful observations. There have been funnels in the air, but none reaching the ground. We have on several occasions sent some of the people out in the vicinity where these funnels were reported, and I am sure some of the federation have done the same thing. But there does seem to be some significance on that part.

As far as research is concerned, I feel that we can improve on almost anything that we do through research. In our department, through the American Waterworks Association, I have been responsible for helping to carry on a number of research projects. In our own department, we have carried on a number, especially water purification, and in the biology effecting our lakes and water supplies, and we are cooperating with the Bureau of Reclamation on evaporation reduction by applying film on the surface of the lake.

We have made biological studies and we are hoping that the Bureau will see fit to carry on—because we are willing to cooperate if they carry on that experiment on our reservoir where we can measure all flow that comes into the reservoir and all the water that goes out.

It would be a very interesting task.

But it has been my experience that, on research, certainly the people that are in charge of a project and those who are working on the research must maintain an open mind and a willingness. It is difficult to change people who have fixed ideas and who have been critical of the very program in which they are going to be asked to participate.

So I heartily agree with the bill, Senate bill 86, as you outline there, in which you have recommended that this research would be placed in the hands of the Advisory Committee on Weather Control. I think that is a good choice, as this committee has had an opportunity to investigate, and to discuss with and observe for several years practically all of our institutions over the United States, and the private enterprises that are now conducting cloud-seeding projects.

They have had that opportunity to make these observations. I think it is ideal. Certainly, in the selection of the group that would have as their responsibility the carrying on of this work, it certainly would take an organization who has an open mind and a willingness to maintain that attitude.

I think we can solve almost any problem we have through research, and am heartily in favor of it.

As far as the State level, I would like to see the definition of the States certainly enlarged at least to take in the customary definition, and that would mean such as State funds or a subdivision of the Government, because our city is a subdivision of government, and we are about the only ones in the State that have provided funds for those projects.

I am sure we will have funds in the future, and we would be glad to cooperate to the fullest extent. There might be even farm organizations which would like to repeat some of their projects.

So I do think it is worthwhile, I think Senator Case is to be commended for sponsoring S. 86. With the increased use of water, it is a very serious matter to meet the growing demands and to provide the facilities. Most places have already developed the cheaper water resources, and now must spend tremendous amounts of money to develop new sources.

In our case, we have to go 100 miles for our next water supply, and it is going to cost in the neighborhood of over $100 million. That is more than twice the total investment that we now have to get our present water supply. Other towns in the Southwest are doing the same thing.

If the assistance, even partially, can be brought about by weather modification, that in itself would be a big factor. We don't want to overlook the fact that increased precipitation—just a slight increase sometimes means the difference between runoff and no runoff. During the drought, in the Central Plains area, many of the streams for hundreds of miles were dry for month after month, even for a year at a time.

That also brings about a terrific problem in the disposal of waste. Without pollution you have got to do a bangup job on treating the waste. That is very expensive.

With all of those factors, I believe we can make a great deal of progress if we get into this program and go forward with it.

Senator BIBLE. Thank you.

Senator Schoeppel, have you any questions?

Senator Case, do you desire to question Mr. Cunningham?

Senator CASE. No questions.

Senator BIBLE. We appreciate your testimony very much. Thank you, sir.

Our next witness is Mr. Stout.

STATEMENT OF GLENN E. STOUT, HEAD, METEOROLOGY SUBDIVISION, STATE WATER SURVEY DIVISION, URBANA, ILL.

Senator BIBLE. Do you have a prepared statement?

Mr. STOUT. Yes, sir. I do.

Senator BIBLE. Thank you. You may proceed.

Mr. STOUT. Mr. Chairman and gentlemen of the committee, my name is Glenn E. Stout. I am head of the meteorology section of the Illinois State Water Survey, Department of Registration and Education, State of Illinois, whose activities are authorized by the board of natural resources and conservation. This board, by the way, consists of a group of scientists there in the State.

The water survey is charged with the collection, analysis, and dissemination of facts concerning water resources in the State of Illinois, and has been in continuous existence for 62 years.

I desire to endorse the basic idea of expanded research in meteorology contained in S. 86 (85th Cong.) which was introduced by Senator Case of South Dakota, and suggest changes for your consideration as amendments to this bill.

Whereas the proposed legislation stresses experimental research in the field of cloud modification and cooperative programs to be accomplished with equal Federal and State funds, I believe that primary emphasis should be placed on basic research in cloud physics on a regional basis.

In Illinois, as well as in the surrounding States, knowledge is limited and quantitative information is meager concerning the processes in which clouds produce precipitation. This lack of basic understanding of the mechanism of precipitation formation emphasizes the illogicality of attempting large-scale seeding modification until these processes are better understood. Secondly, I would encourage cooperative programs in various climatic areas, rather than numerous Federal-State studies, because of the regional nature of weather phenomena.

Extensive cloud-modification studies began just a decade ago, and much credit should be extended to Dr. Langmuir, Dr. Schaeffer, and their staff at the General Electric Co. for their findings. Subsequent major projects of the Department of Defense, University of Chicago, New York University, and other organizations have reported that clouds can be modified, but such studies in the Middle West were handicapped by drought conditions and inadequate aircraft. Consequently, they were unable to collect sufficient data to accurately define the probabilities of modifying cloud structures, and the economical significance of such modification.

In 1948, the State of Illinois recognized the importance of determining the natural conditions of cloud formation and rainfall.

Dr. A. M. Buswell, then chief of the Illinois State Water Survey, presented testimony on House bill 4582, of the 80th Congress, which encouraged the use of Federal funds for weather-control studies.

A small staff was then organized at the State water survey and work was initiated to evaluate the progress being made on cloud-physics research in the United States, and, at the same time, to obtain detailed data on the rainfall in Illinois. Considerable knowledge has been gained on the distribution of precipitation and future research needs since that time.

I might point out for the record, at this time, that in Illinois there have been very few so-called cloud-seeding experiments. We have only encouraged those which were to be done on a controlled, scientific basis. So a lot of money has not been spent in our State by the local residents. A few other States, notably Arizona and California, have initiated research programs in cloud physics and cloud seeding. In these few studies, the duration of the tests and financial resources have been limited, and more intensive basic research is needed to expand our knowledge of atmospheric conditions controlling the precipitation process.

An evaluation of the various studies mentioned in the previous section indicates further research in the fundamentals of cloud physics needs to be undertaken. The known and unknown facts about clouds and rainmaking have been recently summarized by Dr. H. R. Byers, director of cloud-physics research, the University of Chicago, in a pamphlet entitled "Cloud Physics and Rainmaking."

I recommend this pamphlet for your reading, since it has been prepared in nontechnical language for personnel of public utilities, agri-

cultural groups, Government agencies, and others interested in the current status of modifying the weather.

Senator BIBLE. Do you have that pamphlet available to you?

Mr. STOUT. I have a copy with me.

Senator BIBLE. Do you have extra copies that could be left with the committee for the staff?

Mr. STOUT. I do not, sir.

Senator CASE. Mr. Chairman, we have some copies at the office. It is a very interesting brochure, and I think each member of the committee would be interested in seeing it. This is it here [indicating].

Senator BIBLE. I think that it should be incorporated by reference in this particular record, and made available to the members of the committee for their study. (The pamphlet referred to is on file with the Committee.)

You may proceed.

Mr. STOUT. Experiments by the University of Chicago cloud physics project, under sponsorship by the Air Force during 1952–54, and in which the water survey was a subcontractor, indicated that the formation of precipitation in Illinois and much of the Midwest in the summertime is frequently initiated by the coalescence process before the clouds build to the freezing level.

This development in theory is contrary to the generally accepted ideas of rain formation by the ice-crystals process above the freezing level, and is very pertinent to cloud modifications in the Midwest. The data are quite limited and this work should be continued. We propose to undertake such research when funds become available.

Studies also made by the University of Chicago indicate a large variation in the cloud dimension characteristics between the Caribbean area, Central United States, and the southwest portion of the portion.

In view of the large differences between various geographical regions, it is apparent that cloud physics studies should be undertaken in various parts of the United States.

Droughts occur in all parts of the United States. They are not confined to the arid Southwest or the Great Plains. Deficient rainfall in the late forties caused water restrictions in New York City. Although rainfall in Illinois is often classified as abundant, droughts are not unusual.

While a severe drought prevailed in the southwest part of the United States during 1952–55, the southern half of Illinois experienced a similar drought which caused a nearly complete crop failure in 1 year, substantial reduction in yield during the other 2 years, and shortages in numerous industrial and municipal water systems.

During 1 year of the drought, the net farm income was reduced by 30 to 35 percent for hog and grain farming. Statistics of the economists of the University of Illinois also reveal that dairy farming suffered loses of 50 to 60 percent in net income.

It is estimated that 20 inches of water is required by an average corn crop. This water comes either from the stored subsurface moisture or rainfall during the growing season. If spring or summer rains are deficient, crops consequently suffer from a deficiency of moisture. Years of bumper crops are usually the result of an abundant rainfall in late July or early August. Research on methods of providing increased summer rainfall would aid the farmer greatly.

A detailed study by the water survey shows that 50 percent of the southern Illinois communities depending upon surface water supplies suffered shortages during the 1952-55 drought, and over 10 percent of the public water supplies in the drought region relying on ground-water sources experienced deficiencies.

Water resource agencies with active meteorological programs should be enlisted to form regional cloud physics projects since it is impossible to properly classify meteorological conditions by State boundaries.

Furthermore, many States do not have research meteorologists available for individual State projects.

Federal leadership is encouraged on these regional projects in order to perform economical and efficient studies. Coordination of activities is essential in order to prevent duplication of effort.

The benefits that would be gained by further research in the field of cloud physics are numerous. Almost every activity depending upon precipitation would benefit by increased precipitation under controlled conditions.

Two of the more significant applications will be mentioned. Although it has been thought that the rainfall in Illinois is abundant for agriculture, irrigational use is increasing in the State. Water survey studies indicate that there is not enough ground water to support widespread irrigation. As water shortages develop in our expanding economy with attending controversy, development of successful cloud modification techniques would decrease the need for diverting ground water or surface water for irrigation.

Increased knowledge of the precipitation processes on a geographical basis would result in considerable improvement in United States Weather Bureau forecasting. Every activity dependent upon short-range water forecasts would operate more efficiently if accurate quantitative forecasts of precipitation were available.

In summary, I wish to emphasize that it is our strong conviction that a program of research in cloud physics rather than experimental research in the field of cloud modification is necessary. Second, research in cloud physics should be established on a regional basis rather than numerous small, uneconomical projects in various States. The basic idea of research in meteorology suggested by this bill is excellent and the water survey would be willing to cooperate in the formulation of a regional program in this field of cloud physics.

Knowledge in cloud physics has advanced considerably in the past decade, and I am sure that with sufficient funds and personnel, equipment, and leadership, that our understanding of atmospheric water processes will be greatly increased in the next 10 years. Results from meteorological research should not be expected too rapidly since it is difficult to reproduce atmospheric conditions in a laboratory, such as the chemist, physicist, or aeronautical engineer is able to do.

Therefore, considerable data collection and analysis are necessary before sufficient knowledge is obtained to fully understand the physical factors involved.

Senator BIBLE. Thank you very much for that statement. You heard the testimony this morning, if I understand it correctly, it was from Dr. Schaefer, of the Munitalp Foundation, to the effect—the effect of his testimony as I understand it was both this basic research and this applied research should go hand in hand, together.

That seemed to the Chair to make some sense that you have to move both of them along together. I see here, if I read your testimony correctly, that you feel that there should be more emphasis on the basic research rather than upon applied research.

Mr. STOUT. Yes, sir. When you get to applied research programs, they become quite costly and you start running the dollar sign up rather rapidly. But much basic research as Dr. Waterman mentioned previously can be done in a laboratory with a small amount of money. When you start distributing $1 million over a number of regional projects there isn't very much for any one group. So that it is better, I think, to confine it to the basic in the early stages.

Senator BIBLE. I am glad to get your viewpoint on that.

Secondly, you suggest that it be established on a regional basis rather than on numerous small uneconomical projects in several States.

How would you specifically do that, on a regional basis?

Mr. STOUT. That seems to make some sense. I mean the far Western States have one general problem, the southwestern region another problem, our region in Illinois possibly another, possibly the Pacific Northwest has a different set of facts governing it.

Senator BIBLE. Do you think the Advisory Committee on Weather Control as set up in this proposed bill is the correct committee to authorize and to direct this program?

Mr. STOUT. I haven't been too close to the Advisory Committee work, only in an indirect way. I don't think I can comment on that, sir.

Senator BIBLE. But you do feel that the bill should be broadened out in its objectives, you think it is kept too narrow in just the field of cloud modification?

Mr. STOUT. That is right.

Senator BIBLE. Since National Science Foundation is set up for basic research it appears they would be the local group to undertake this work.

Senator BIBLE. Senator Schoeppel?

Senator SCHOEPPEL. No questions.

Senator BIBLE. Senator Case?

Senator CASE. I think Mr. Stout has made several valuable suggestions. I might make this observation with respect to this being on a State basis or regional basis.

The suggestion in the bill merely states public agency. It wasn't expected that the program would be applied in any State where there wasn't some interest in it. This is not a suggestion of a program like a public roads program where you allocate so much to each State.

It would be expected that the land-grant colleges, if they were to ask for cooperative programs, would be only those colleges which are in areas where they have a water problem. Unless there were something in the State law that limited them to working just within the State, their activities might be more than statewide.

In other words, I think that the bill contemplated studying the problem from the natural region that is associated with cloud formation.

The little booklet to which Mr. Stout referred is a very illuminating one. It has just recently been published by the Department of Meteorology at the University of Chicago. Dr. Horace R. Byers, the chair-

man of the department has written me a letter with respect to the earlier hearing which I will make available to the committee a little later. This booklet is as recent as this, that it bears the imprint of February 4, 1957. It starts off with a rather striking sentence, "more than 6 times as much water flows across continental United States in the air as is carried by all the country's great rivers."

It concludes with this interesting paragraph:

> The inflight cloud-seeding tests of the University of Chicago cloud physics research group proved conclusively that it is possible to initiate the rain process in certain cumulus clouds through the introduction of large quantities of water spray. The rain at the ground can also be increased by an amount that is thought to be small. Tests involving the introduction of dry ice into subcooled cumulus clouds were inconclusive, but further work is anticipated. The next step is to test the use of silver iodide, especially as put into the atmosphere from an airplane.

The booklet takes up the structure of ice and snow crystals and the structure of raindrops, compares the size of raindrop particles with the particles from silver iodide mist, and it is a very interesting booklet. It is copyrighted, I don't know whether that would interfere with it being put in the record.

But certainly the members of the committee ought to have as many copies as they can use.

Senator BIBLE. This is adopted by references in the record.

We will ask the staff to see if it is possible to secure other copies of this pamphlet for use of the subcommittee.

Any further questions?

Thank you very much, Mr. Stout, we appreciate your testimony.

Our next witness is Mr. Langfitt.

Do you have a prepared statement?

Mr. LANGFITT. Yes, sir.

Senator BIBLE. Proceed.

STATEMENT OF MERRILL J. LANGFITT, FARM SERVICE DIRECTOR, RADIO STATION KMA, SHENANDOAH, IOWA

Mr. LANGFITT. Mr. Chairman, my name is Merrill Langfitt. I live in Shenandoah, Iowa, and am farm service director for radio station KMA. I am not representing any commercial organizations here except my employer. In our business of radio broadcasting, we are interested, among other things, in giving service to farmers.

One of those services revolves around weather information. Last year when we were extremely dry, and had been for 3 years, farmers of our area asked assistance in setting up a weather-modification program.

It is not my purpose here to evaluate that program, but rather to convey to you the reaction of our farmers to such a venture. One of the most valuable aspects, it seems to us, is to have an accurate, long-range weather forecasting service from the people who are at present engaged in carrying out our weather modification efforts.

As you well know, the attitude of farmers in a large way guides their behavior. In March of this year, Dr. Irving Krick appeared before 700 farmers in the KMA auditorium and told them that his long-range forecast called for above normal precipitation for April, slightly below normal for May, above normal again for June, and slightly below normal for July and August. At the same time he told them

they could expect, as a result of cloud seeding, to have normal or slightly above precipitation for the entire growing season. Dr. Krick's forecast put new life into our area. Seedsmen started selling seeds, fertilizer sales boomed, bank credit loosened up, retail sales took a spurt, and business in general was very good.

Dr. Krick's forecast has held true to this date and regardless of the cloud-seeding efforts, an accurate long-range weather forecast is worth the cost of our entire modification program. I might add that 6 weeks after Dr. Krick made his forecast, the Weather Bureau came through with essentially the same forecast.

It is not my purpose to criticize the Weather Bureau, because we use their service, too. We should recognize, however, that the Weather Bureau is conservative and I'm afraid they are not always most effectively employing new methods and new equipment in forecasting.

I might add that Dr. Krick sends to KMA by telephone a daily weather forecast direct from their weather laboratories in Denver, pinpointed to our specific area. These forecasts have been very accurate and of great monetary value to our farmers. This service is provided to our farmers at no cost, in fact, Krick pays the telephone costs and gives our farmers the benefit of their vast weather information as a part of their service in the Iowa-Missouri weather modification area. Of course, by means of radio, the forecast service reaches farmers in the entire four-State area served by KMA, including part of Senator Schoeppel's State of Kansas.

I have given you this information as a prelude to building a case for private weather forecasters with reference to the service they can perform in weather research. These private forecasters such as Dr. Krick and his organization, employ personnel in the field who are close to the people and to the weather as it exists and as it develops from day to day.

This is purely conjecture on my part, but I feel that our most important weather research in the future must come, in part at least, from the commercial weather organizaitons. They will not be limited by slow conservative bureau policies, but can progress as fast as their funds will permit. By the very nature of their operation, they will need to be alert and aggressive.

Their income is directly dependent on their skill; therefore, they must continually move forward in weather research. Our farmers have developed a tremendous degree of confidence in Dr. Krick's organization, based on their past performance. I believe that Federal funds in the hands of those who are now conducting field operations in weather modification, would in a short time, give us new and valuable information about the complex phenomenon of weather.

I believe that even today some of the private forecasters have more statistical weather data than the Weather Bureau and that such data is being well applied in ways that are serving well to give farmers accurate weather information.

It would be the hope of myself and the farmers that I represent that we will see the time when Government funds may be forthcoming to match funds raised by farmers to increase the scope of our weather knowledge and then apply that information in ways that will better serve the needs of all of our communities.

No doubt the Weather Bureau can do more than they are now doing if they had more funds, but we feel that additional funds in the

hands of those already doing weather modification would greatly advance that science of weather modification and accurate forecasting.

We think it is very desirable, from a purely economic standpoint, if nothing else, that more weather research be done. Federal funds must be allocated for at least a part of the job. Farmers, businessmen, and commercial meteorologists can very well make an important contribution to any weather research that may be done, thereby supplementing the work done by the United States Weather Bureau.

I have observed to some extent the work of the advisory committee and have been impressed with the detail of their evaluations of projects. They would be a logical group to supervise weather research work in the field and with them lies the greatest opportunity for further research. Certainly the advisory committee should continue their present activities for several more years and preferably with more funds to work with.

I have attached a sheet which is self-explanatory except I would like to comment on it. We started our weather modification program in June of last year.

Senator BIBLE. What type of a program was your weather modification program?

Mr. LANGFITT. This was a cloud-seeding program for the purpose of inducing precipitation.

Senator BIBLE. Thank you.

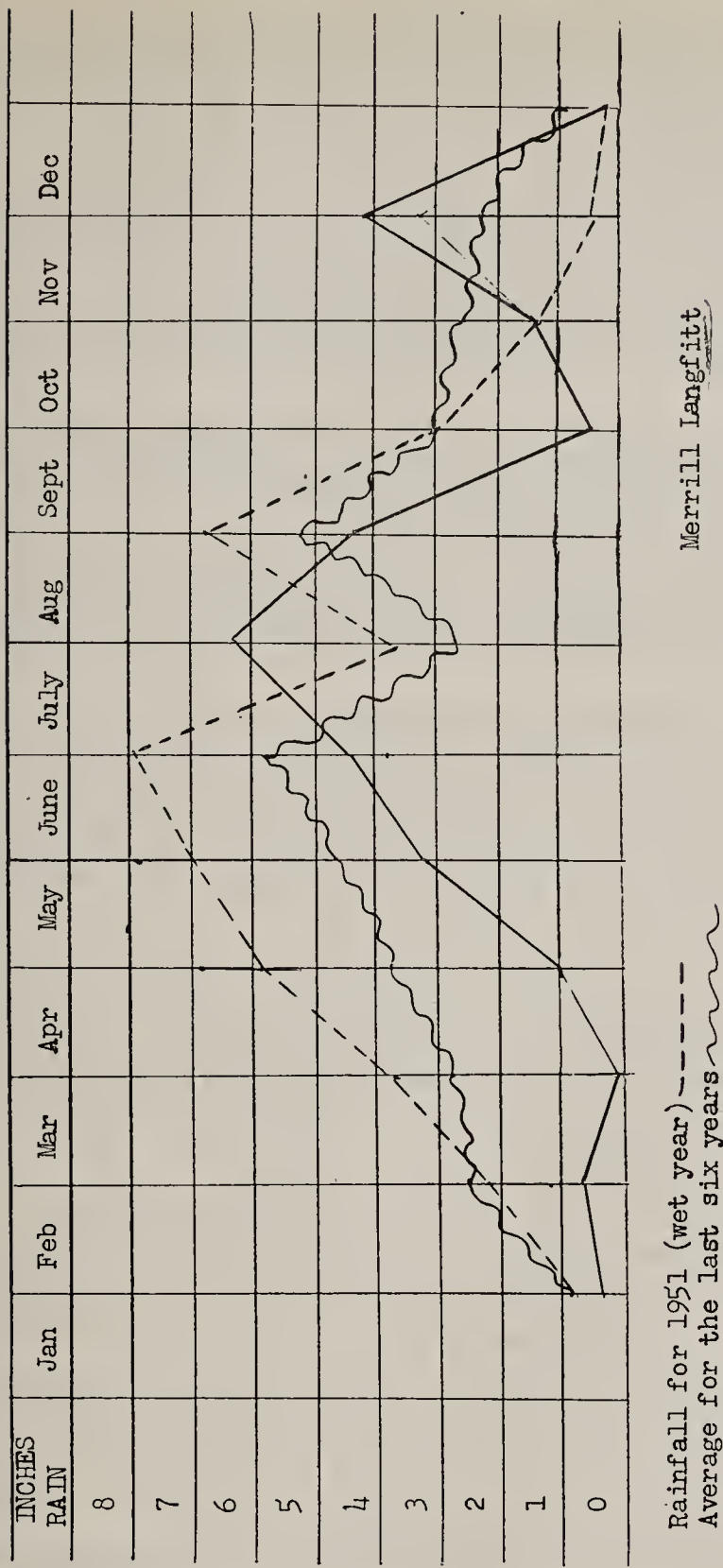
(The document above referred to is as follows:)

Rainfall, January 1951–January 1957

Year	January	February	March	April	May	June
1951	0.55	2.03	3.46	4.97	6.84	7.91
1952	.37	.68	3.00	4.00	3.30	4.93
1953	.26	1.13	2.48	2.27	1.37	5.27
1954	.20	2.12	.90	2.77	4.08	7.07
1955	1.58	2.06	.50	1.88	3.16	7.00
1956	.40	.53	.10	1.11	2.37	3.44
1957	.57					
Total	3.36	8.54	10.44	17.00	21.12	35.62
Average	.56	1.42	1.74	2.83	3.52	5.94

Year	July	August	September	October	November	December	Total
1951	3.89	6.77	3.02	1.82	0.79	0.67	42.72
1952	3.45	6.27	2.18	.01	3.09	.84	32.12
1953	2.22	2.76	1.26	.32	1.25	1.88	22.47
1954	.34	9.27	1.42	5.72	.13	.43	34.27
1955	1.68	1.80	3.66	1.03	.18	.34	24.87
1956	5.39	4.67	.59	1.30	3.29	.19	23.38
1957							
Total	16.97	31.54	12.13	10.20	8.73	4.35	179.83
Average	2.83	5.26	2.02	1.70	1.45	.73	29.97

You will note the close resemblance on the graph of the line representing average precipitation for 6 years, the line during the wet years and the line during 1956. The main difference being in the amount of rainfall, but not in the peaks and lows. Take notice also of the peak last year in July at a time when lows occurred in the other two lines. We are wondering if cloud seeding caused this deviation in pattern. Cloud seeding started about the middle of June, so we are, at least for the sake of argument, suggesting that we might have had a low last year in July, following the general pattern, had it not been for cloud seeding. Another thing worth considering is that if we had had a low in July last year, we would have had a virtual corn-crop failure. My assumption is that the high peak we hit in July is the only thing that gave us a corn crop last year.


INCHES RAIN
8
7
6
5
4
3
2
1
0
Jan
Feb
Mar
Apr
May
June
July
Aug
Sept
Oct
Nov
Dec
Rainfall for 1951 (wet year)
Average for the last six years
Rainfall for 1956
Merrill Langfitt

Mr. LANGFITT. We had very little opportunity during the balance of June. In July we had some opportunities for cloud seeding. As you can see, we got some results. I would like to refer then to the graph down below. The top line represents the average of the last 6 years at Shenandoah, Iowa, precipitation. I would like then to refer to the wavy line which represents—wait a minute. Let me check back. The broken line is a wet year, 1951. The average of the 6 years which is the wavy line, as you notice, follows almost identically the same pattern. Last year that weather pattern changed and you will notice that in July we jumped up to 5.39 inches.

Now my contention is that what happened in July last year is what gave us a corn crop. Without that peak in July, if we had followed the normal pattern, we wouldn't have had a corn crop in our area last year.

Then you can follow some other months through. We had pretty good seeding opportunities in August. You will notice we got 4.67 last year. The average of the last 6 years is 5.26. We are still below. But we were in a dry cycle as you know.

September there wasn't a cloud in the sky during the whole month of September in our area. In October we did a little better than we did the preceding year. In November we had some good seeding opportunity, we jumped up to 3.29, compared to 1.29, the average of the last 6 years. I only enclose that sheet for the information it might contain.

I have seen some weather modification work for a number of years. My first experience with it was about 1953. We went up in an airplane and did some seeding with Dry Ice and in one particular instance we saw clouds completely change their structure. They began to get black almost immediately after dropping the Dry Ice and it seemed to spread out across the sky, and as a result of that little venture, we got 1.67 in a rather small area, the surrounding area didn't get more than about half of that.

Now water is a very big factor with us. What is important agriculturally, without water we don't have crops and it affects our economy in that way. We hear a lot of talk these days about farmers being moved off the farm because they can't survive. If we are going to have a continuing change from small farms to big farms, those people, many of them, are going to have to find some place to go. We can't develop industry in our area without water. Water is a very important consideration.

Then there is another important consideration, it seems to me, and that is recreation. If we are going to keep our young people in our agricultural communities, we need recreation. Water fits in with all of that. Water is our limiting factor. We can put on the fertilizer, we can put on the seed, but still we don't do much with all those ingredients of production unless we have water.

We feel we have had results. Again I don't think it is good policy for us to specifically say that we know we did, I don't think any group or individual can say that we know this works, we know it doesn't work. The point is we do need more research, more answers. We think that research under the direction of the Advisory Committee would be at least a partial solution to that problem.

Now there has been talk about splitting the funds up among several agencies. Well it is my understanding that the Advisory Committee

already is represented by several agencies and by several phases of the whole program. So we have that balance in the Advisory Committee already. My personal favor would be toward putting these funds that are to be appropriated in S. 86 in the hands of the Advisory Committee to carry out this program.

Now that is the context of my prepared testimony and the comments I had to go with it.

Senator BIBLE. Thank you very much, Mr. Langfitt. Splendid statement. Senator Schoeppel, do you care to question Mr. Langfitt?

Senator SCHOEPPEL. No questions.

Senator BIBLE. Senator Case you may question Mr. Langfitt.

Senator CASE. Did you continue your seeding operations last November?

Mr. LANGFITT. Yes, we started in about the middle of June and they are still underway.

I don't have the figures here for this year so far. By the way, it is raining in Shenandoah this morning, or it was, and I hope some of that is falling on Kansas, too, Senator Schoeppel. We have had so far this month, I have those figures in mind, about 2.35 inches up to the 13th, in addition to the rain that is falling there now.

Average of the last 6 years is 2.83. I presume by this hour, today, we probably have about normal for the month of May, and it is only the 13th of the month.

During February we were approximately normal and during March we were above normal. The thing that has happened, we have had 3 years of drought, we have had 3 half crops, and now we have moisture and our country is in the best shape it has been in for a long time.

I am not going to sit here and say crop seeding did it. We are encouraged about it, our farmers are encouraged. I am certainly not in favor of this bill being under the direction of anybody who already has their mind made up that cloud seeding will not work. I think we need to be openminded on it.

Senator CASE. Mr. Chairman, it was interesting that they established a peak for last year in the month of July which, looking at the 6-year record, was a month which normally was producing only 2.83 inches of rainfall. The July of last year is the best July they have on record in this 6-year average.

Mr. LANGFITT. That is right, Senator Case.

Senator CASE. It did the same thing again in November. That is why I wanted to know whether or not they were seeding in November.

Mr. LANGFITT. Yes, we were. You will note in July of 1951, which we considered a wet year, we had 3.89, compared to 1956 total of 5.39. I realize rainstorms can develop which, in a particular month, give you a lot of rain. I am not going to sit here and say cloud seeding did it. But the accumulative results since cloud seeding started, we have been impressed with. I still don't think you can draw conclusions at the end of 1 year or maybe 2 years; I think it takes a long time.

Senator CASE. I think we ought to keep that constantly in mind.

Mr. Langfitt, are the reports being made regularly to the advisory committee of the conditions under which the generators are put to work?

Mr. LANGFITT. I am sure that they are. I should point out that I have no association with an office or anything in this weather modifi-

cation program. We helped to organize and set it up. They have their own officers. They have their own nonprofit organization, their own funds. Those funds are channeled into IMO, a nonprofit organization of about 11 or 12 counties. I have been told that their findings are going to the committee.

Senator CASE. I assume they are. But if we are going to get the maximum benefit from these operations, it is necessary that we know the conditions and the methods used in each operation.

Mr. LANGFITT. Very true.

Senator BIBLE. Thank you very much, Mr. Langfitt.

The next witness is Earl Darling, of Emmettsburg, Iowa.

Do you have a prepared statement?

Mr. DARLING. No.

Senator BIBLE. Will you be seated and identify yourself for the purpose of the record?

STATEMENT OF EARL DARLING, NORTHWEST IOWA RAIN INCREASE ASSOCIATION, EMMETTSBURG, IOWA

Mr. DARLING. Mr. Chairman, members of the committee, my name is Earl Darling; I am from the Northwest Iowa Rain Increase Association, of Emmettsburg, Iowa.

Our area contains 10 counties and all I know about weather modification is what has happened in our immediate area.

Senator BIBLE. Your association is a voluntary association made up of the farmers of the 10 counties in northwest Iowa?

Mr. DARLING. Yes, sir.

Senator BIBLE. When did you so organize?

Mr. DARLING. On the 26th of June.

Senator BIBLE. Of last year, 26th of June of 1956?

Mr. DARLING. Yes.

Senator BIBLE. You might tell us about your association, what you have done.

Mr. DARLING. It was getting dry last spring and we organized the Northwest Iowa Rain Increase Association. From then on we began to get a little more precipitation and we feel that they have done us some good.

Senator BIBLE. What did your organization specifically do, Mr. Darling? You said you organized and then you started getting some precipitation.

Mr. DARLING. Well, they started the generators going and seeded every cloud that came along, where there was an opportunity.

Senator BIBLE. Did your association enter into contracts with regular ground seeding contractors?

Mr. DARLING. Yes; with Dr. Krick.

Senator BIBLE. You entered into a contract with Dr. Krick?

Mr. DARLING. Yes. Before we started we were getting clouds, but there was no rain. After the cloud seeding started, we had rain in our area.

Senator BIBLE. That was during July and August of last year, sir?

Mr. DARLING. Yes.

Senator BIBLE. How long did you continue your operations?

Mr. DARLING. They are still in operation.

Senator BIBLE. Very well.

Mr. DARLING. Our contract with the Water Resources Development Corp., of Denver, Colo., expires on the 26th of June 1957.

To the south of us is some of the best land in Iowa. They suffered from the drought. Our four counties, using Dr. Krick's services, got our operation going in time to do us some good. Other counties, that hung back, had crop damage and their crops were burned.

Senator BIBLE. You have a feeling that if they had gotten in the same time as you did, they would have had the same results?

Mr. DARLING. Yes, Senator I do. I went down to those counties in August, I was visiting relatives who live there, and they told me that the rain they were getting then was too late to be of benefit. They said that if the rains coming then had come six weeks earlier they would have made a crop. As it was they did not pull their corn pickers out at all.

The county south of us did not use Dr. Krick's services. Their crop was about 50 percent of normal. The next county had a total crop loss. That occurred all along the south side of our target area.

We had a good crop, getting yields of 75 to 120 bushels per acre. I personally had corn that made 120 bushels to the acre. However, the average crop in our area was about 75 bushels.

We had an increase in rain. Our crops increased and those not doing any cloud modification work had drought.

As I said, we had crops and we paid income taxes—we had incomes.

Senator CASE. You must be a good corn farmer, too, if you got 120 bushels.

Mr. DARLING. Senator Case we have good soil, good farms.

Senator CASE. I was born at Everly, Iowa, the witness doesn't know that, but——

Mr. DARLING. We are not far apart.

Senator BIBLE. Do you plan on renewing your contract this year?

Mr. DARLING. We are working on it at the present time.

Senator BIBLE. You are pretty well sold, from your testimony.

Mr. DARLING. I am 100 percent sold.

Senator BIBLE. That it was a good project last year, and it will be the same way in 1957.

Mr. DARLING. It is a difficult program to sell to the farmers. You cannot guarantee results. I knew nothing of weather modification until last year. I am a farmer, having farmed all of my life, and I was not familiar with cloud seeding. However, I have about 1,000 acres there in Iowa and I was willing to gamble to get rain.

Senator BIBLE. I think you make a very fine witness. You didn't have rain and you went into the program and you sold the program.

Mr. DARLING. You can see why I am so interested.

Senator BIBLE. I think you make a very credible, very splendid witness.

Mr. DARLING. That is my livelihood, my farm. We have a very serious situation there right now.

Last year, after we started seeding clouds, the southwest and west areas of our target were unfortunate. They did not have clouds there to seed and they were also pretty late for a crop. They did not get the fall rains that we had. Now the situation seems to be reversed. In the first part of May we had a little overcast and a sprinkle of rain—two-tenths of an inch.

In April, the first part of April if I remember correctly, we had snow, about an 8-inch snow. Last Thursday and Friday, May 9 and 10, we had a half inch of rain. That is all of the moisture that we have had this season.

Then we had a hot 80° temperature with the wind blowing, a hurricane. Everyone knows that really takes the moisture out of the ground.

At this time we are in very bad shape and desperately need rain.

Senator SCHOEPPEL. Have you been seeding and treating all during this time?

Mr. DARLING. Perhaps I did not make myself clear, but there have been no clouds to seed. It was slightly overcast the times that we got the two-tenth and half-inch rains.

Senator SCHOEPPEL. On these overcast periods that is when you seed?

Mr. DARLING. That is the time that we do the cloud seeding. There were no real clouds those days, no real thunderheads, it was just overcast. We did get slow gentle showers as I just mentioned.

Senator BIBLE. How much does a contract such as you have described cost the Northwest Iowa Rain Increase Association? What would be the total cost?

Mr. DARLING. We have just slightly over 3 million acres in our project.

Senator BIBLE. Does that cover the 10 counties or the 4 counties?

Mr. DARLING. The 10 counties.

Senator BIBLE. I see.

Mr. DARLING. And it costs 2 cents an acre, which is very low.

Senator BIBLE. It costs 2 cents an acre and the farmer is billed upon the number of acres that he holds, is that a correct statement?

Mr. DARLING. Yes. When we organized we knew that we would not be able to sign up every acre. The program is voluntary. To insure sufficient funds to go through with our contract we charged 5 cents an acre. All of the counties made the same charge.

We had a little difficulty in our county. The east half of the county was getting some moisture at that time, the spring of 1956. They could not see the need of a cloud-seeding project then. Now, in 1957, they too are short of moisture.

Senator BIBLE. If it is possible to sell the owners of this 3 million acres upon a new cloud-seeding contract, you intend doing it this coming June; is that correct?

Mr. DARLING. We are hoping to, yes; we are hoping to. There is no way to force anybody.

Senator BIBLE. I recognize that, it is purely voluntary.

Mr. DARLING. No one can be forced to join in the program.

Senator BIBLE. But you feel it has shown worthwhile results and has produced?

Mr. DARLING. Definitely; we think it has.

Senator BIBLE. Do you feel that this bill before the committee is a worthwhile bill to continue research in this field?

Mr. DARLING. Yes, sir; we are for S. 86.

Senator BIBLE. Senator Schoeppel?

Senator SCHOEPPEL. No further questions.

Mr. DARLING. Sitting, here at the committee meeting, I was just thinking about how this program would work out. It is quite similar

to the way we educate our Iowa farm boys. You can send a boy down to Ames, where we send our boys, to receive his scientific training—to learn from the books about farming. He can learn all there is to learn in the books, but if he does not get out in the fields with our diesel tractors and hydraulic machinery, he will have difficulty in applying all of his scientific knowledge. So what I am trying to say is that I think that field research is also important.

Senator BIBLE. Thank you very much, Mr. Darling. I think you have made a real contribution to this hearing.

Senator Case?

Senator CASE. I think that last illustration is very good. A boy might go to Ames and study mechanical engineering or——

Mr. DARLING. He can study all about crops, all about fertilizers, but if he knows how to go out and use this knowledge, he is much better off.

Senator CASE. And he might learn something there in applying it that he wouldn't really understand unless he had done it.

Mr. DARLING. If he had no experience at all beforehand, he could study until he was gray headed and I will bet anything that he couldn't go out and do the job, and do it right, because he wouldn't know how to operate the machinery. I can't see but what this is the same thing with cloud seeding. If you didn't have some experience along with what you learned in the laboratories, you wouldn't be too successful.

Senator BIBLE. Thank you very much, Mr. Darling. We appreciate the testimony.

Mr. DARLING. That is all that I have to say. I appreciate the opportunity of appearing before the committee.

Senator BIBLE. I think it helps the committee a great deal.

Our next witness is Mr. Dennis, vice president and chief meteorologist, of Weather Modification Co., San Jose, Calif.

Mr. Dennis.

STATEMENT OF ARNETT S. DENNIS, WEATHER MODIFICATION CO.

Mr. DENNIS. Mr. Chairman, I don't have a prepared statement. My name is Arnett S. Dennis, and as the chairman said, I am the vice president of Weather Modification Co.

I might mention that before becoming a cloud-seeder, I was at McGill University in Montreal, Canada, and got a doctor of philosophy degree in physics, so I have a reasonable background even though I am now in a somewhat questionable occupation. [Laughter.]

Senator BIBLE. The occupation, your background well qualifies you.

Mr. DENNIS. Well, my thesis subject was radar study of precipitation processes, so I guess it did fit in. I thought I would come here and start out by telling you that you need water and that the whole country does, but since that has been taken care of very well I will skip the obvious point.

It should be mentioned, though, that no part of the United States is immune to drought and to other sources of disaster, such as hail, and I don't know what the chamber of commerce back home will think of me, but I was very surprised in getting to California that they even have hail out there, too.

Now, the only point I would like to make is that I think this money, if appropriated, should be spent in a systematic manner and not dissi-

pated to further pet projects of people scattered all over the United States.

Senator BIBLE. How do you suggest we do that?

Mr. DENNIS. Well, I planned on suggesting that it be handled through the advisory committee, or if they are allowed to lapse on June 30, 1958, as currently scheduled, that some similar setup be used to control the funds in question.

I think, to begin with, we should find out from people operating in the weather modification field what things they chiefly want to know to help them do a more effective job.

For one example, we need some kind of a nuclei counter so that we will be sure that when we are seeding a given air mass that we are not merely trying to duplicate something that nature has already done for us.

The only other point I might make is that someone mentioned this morning that cloud-seeders are a little bit nervous about tackling big clouds. I might say that last summer I was on a project seeding hailstorms in Scotts Bluff, Nebr., and on that project our pilots on a routine basis made penetration runs through hail-bearing thunderstorms, and that we thought, and I still feel that we achieved some success in modifying hailstorms in that area.

Senator BIBLE. You are in an area that is very close to the San Francisco International Airport. Have you ever had any occasion to get into the fog-lifting part of this problem, by way of weather modification? San Jose is what, just about 30 miles from the airport.

Mr. DENNIS. No; I have never had any contact with a fog-dissipation problem.

Senator BIBLE. I see. I thought you might possibly have run into that. San Francisco Airport is fogbound a good many days in a year as you well know.

Did you have anything further to add, Mr. Dennis?

Mr. DENNIS. No; I don't believe so.

Senator BIBLE. Senator Case?

Senator CASE. You said you worked on the hail-suppression project near Scott's Bluff.

Mr. DENNIS. Yes.

Senator CASE. Somewhere I read the observation that for dissipating a cloud, if one were working with an airplane, that the technique would be to seed above it or in the upper part of the cloud, but if you were working for moisture that you would seed in the lower part of the cloud or just under the cloud, if you were using silver iodide. Would you care to comment on that?

Mr. DENNIS. I don't quite understand what the person making that statement was getting at. The silver iodide has certain temperature levels at which it is effective. The most straightforward way of getting it there is to fly an airplane to that level and get it into the cloud. Otherwise you rely on the updrafts from the base. I don't see why in one case you would seed below and in the other case seed above.

Senator CASE. The observation of this writer, and I am sorry, I don't remember where it was that I read it, but it was recently, his suggestion was that seeding in the upper part of the cloud would tend to slough off that part of the cloud and dissipate it, whereas if you used the silver iodide and seeded the base of the cloud or just

below it, that drafts would carry into the cloud as a whole and that you would get the maximum precipitating effect without skimming off the part of the cloud that would be building up.

Mr. DENNISI. Well, I mentioned that we need a method of counting natural nuclei. We also need to know what is the optimum number of nuclei. We are working in the dark from two directions: We don't know how many are there and how many should be there. The only basis we have for hail suppression—and it is on a pretty sound basis—is that the more nuclei for a constant amount of water, the more particles result. If you have more participles they will be smaller and hence they will melt before reaching the ground. That is the theory and it appears to hold since the rain that falls from seeded storms tends to consist of smaller droplets than that from naturally produced showers.

Senator CASE. That observation is one that I have heard many times, Mr. Chairman, that a finer, more of a mist-like type of rain develops following seeding operations. I think this illustrates, however, that what we need is more research, more experience in an analysis of the conditions and the results.

Senator BIBLE. Thank you, Mr. Dennis. We appreciate your being here.

Our next witness is Mr. William Raabe.

Senator CASE. Mr. Chairman, Mr. Raabe is not a stranger to congressional committees. He has been down here on various occasions. He is a very sturdy leader in his community, and it is a personal pleasure for me to see him here today. I should say, though, even with respect to him as well as these other witnesses, I haven't conferred with them, I don't know what they are going to say. I thought that perhaps I should say that because what I said when Mr. Darling was appearing—he came from a good part of Iowa—but I had never met him.

Senator BIBLE. Mr. Raabe; we will now hear from Mr. Raabe.

STATEMENT OF WILLIAM RAABE, CHAIRMAN, SOUTH DAKOTA WEATHER MODIFICATION COMMITTEE, TYNDALL, S. DAK.

Mr. RAABE. Thank you, Mr. Case, and Mr. Chairman, and members of the committee.

My name is William Raabe, I am a farmer in Bon Homme County, S. Dak., and I also am the chairman of the South Dakota Weather Modification Association.

Senator BIBLE. What type of association is that?

Mr. RAABE. It is a somewhat loose association. We have in South Dakota 7 organized districts which consist all the way from 2 to 7 counties in a district. I would like to say the particular district in which I live was organized late in July, it started operation about August 1. That consists of the better part of 7 counties in the southeastern part of South Dakota.

I would say that in the last 2 years in South Dakota we definitely witnessed drought. I have lived my entire lifetime in the State of South Dakota. Moreover, I have lived my entire lifetime on the farm that I am now operating. I have seen great changes.

I can remember that we used to have a water supply of shallow wells in our area from which we would pump a plentiful supply of water

at a depth of anywhere from 20 to 40 feet. Our water level definitely has dropped. We are now pumping wells, none of them less than 200 and some up to 300 feet deep. We had to go down to a sand bed to find the water supply.

The people in South Dakota, probably not just in South Dakota but in the Nation as a whole, are water conscious. We are aware of what has taken place, our surface water is lowering and our water consumption is increasing, we realize the value of water. No matter what walk of life and no matter what we may do, there seems to be water involved.

In South Dakota, an agricultural State, if we do not get rainfall we are in trouble. We must have water, either rainfall, irrigation water, or any other means of getting moisture into our soil.

Senator BIBLE. What is the average rainfall in your district?

Mr. RAABE. In the eastern part of South Dakota we have an average rainfall of from 19 to 21 inches. The western part of the State, if I remember correctly, will run on an average of 8 to 12 inches. There is quite a variation in rainfall in the State of South Dakota.

I am here today to say to the committee that the people of South Dakota are greatly interested in all proposals having to do with weather modification. Last year, some areas of our State were in very bad shape due to lack of sufficient rainfall and moisture. These conditions of insufficient water naturally causes them to start thinking about ways to overcome that shortage.

We have heard of Senate bill 86 and the feeling among our people is that every effort be made to further all experimental weather modification projects.

In South Dakota there is always a certain time of the season when we sorely need moisture. This occurs annually, so it seems. If we could only increase our annual rainfall by 10 or 15 percent we then would have a supply of moisture in our subsoil to carry us through. As we are always in the low rainfall area, and just on the verge of drought, a slight decrease of moisture brings disaster to us.

Senator BIBLE. Has your committee or association attempted to enter into any contracts for cloud-seeding operations?

Mr. RAABE. Yes; we have. My particular area has entered into a contract for 1 year with the Denver Weather Modification Corp.

Senator BIBLE. That is a contract in effect at the present time?

Mr. RAABE. The contract is in effect at the present time. We started July 1 and it will discontinue June 30, 1957.

Senator BIBLE. What results did you note from the cloud-seeding program?

Mr. RAABE. Unfortunately, we did not get our project going until late in the season. In September 1956 we did receive some rainfall. This was badly needed and did give us some fall pasture. It also gave us a little subsoil moisture which we badly needed. During the winter months our snowfall was light. However, in March 1957, we had two good snowfalls. These gave us about an inch and three quarters of moisture.

Senator BIBLE. That is this March just past, March 1957?

Mr. RAABE. That is right, in 1957. And in the month of April we had two good rains that gave us an inch and a half, so at the present time our condition is, for this time of the year, we would say are good.

Now, I realize that it is very hard, probably, to measure the results of cloud seeding, but we cannot help but think that with the clouds that we have, and the amount of moisture that we get in that particular season, that we must derive some good out of cloud seeding.

So I certainly would like to commend anybody that is connected or has any thought of trying to do something as far as weather modification is concerned. I believe we have tried things that are far more impossible that are reality today. I cannot help but think let us not give up. If we don't succeed, let us find out why we haven't, what we have done wrong.

Senator BIBLE. May I ask you if you report the results of your cloud modification to this Advisory Committee on Weather Control? Do you make reports to them?

Mr. RAABE. Our State college gets the report on all operations. We, as a committee, get a weekly report on all operations that have taken place within our district.

Senator BIBLE. The various districts report to your committee and also report to your State agricultural college in South Dakota?

Mr. RAABE. That is right.

Senator BIBLE. They in turn possibly report to the Advisory Committee?

Mr. RAABE. I imagine they do.

Senator BIBLE. You do not make a direct report?

Mr. RAABE. I wouldn't be able to answer that question, but my thinking would be that they certainly do.

Senator BIBLE. I see.

Mr. RAABE. I also feel that we are well pleased with the action that has been taken and the efforts that have been made so far. I would like to commend the Advisory Committee. To my way of thinking they have been active. I think this program must be in the hands of some committee that will see it through, that is active.

I can't emphasize too much the definite need of adequate water supply. If we can only find some way and some means of increasing the water supply, I don't see anything that we could derive more benefits of than of that. I really feel that way.

Senator BIBLE. Thank you very much, Mr. Raabe. I think you have made a contribution to the committee.

Senator Case?

Senator CASE. Mr. Raabe, do you know how many acres are in your association?

Mr. RAABE. Right offhand, Senator Case, I don't. What I have been talking about is what we call the Sioux Valley Weather Modification District, in the southeastern area of the State.

Senator CASE. How do you get your funds, by charging so much an acre?

Mr. RAABE. That is correct.

Senator CASE. That is on a voluntary basis?

Mr. RAABE. Our contract is 2 cents an acre, and these were all voluntary contributions.

Senator CASE. If one put in for 200 acres that would be only $4?

Mr. RAABE. Well, as has been mentioned here before, we took donations of 5 cents an acre, because we all know that there isn't 100 percent participation. But we did arrive at a large enough sum to sign

a 1-year contract and operate on 2 cents an acre. In my particular area the folks have contributed $39,000 in 1956–57. To further show the interest of the people of the entire State of South Dakota, the people have contributed a total of $500,000 since 1951 for the over 60 counties in the State that have operated weather modification projects since that time.

Senator BIBLE. When you do your cloud seeding though, you do that over the person who doesn't pay as well as the person who does pay?

Mr. RAABE. That is correct. And we visualize that that is an impossible task to continue doing that.

I would like to refer to the interest of the people in our State. The South Dakota Legislature saw fit to pass a bill, which was connected with an appropriation, for experimental work. We cannot help but think that the people are thinking—they can see some light.

Senator BIBLE. I think the people in your State are to be commended on that action, and particularly to be commended on the foresight that your able Senator has had in this field. I believe that the doctor from the agriculture department of State college of South Dakota, testified to the legislation that was passed at this very recent session of your South Dakota Legislature, which you just mentioned. So we think you are to be commended for the pioneering work that you have done in this field.

Did you have anything further?

Mr. RAABE. No, I think that completes my testimony, and I certainly want to thank you for having the opportunity of presenting it.

Senator BIBLE. We certainly appreciate your being here.

Before I excuse you, it is quite possible that Senator Case might have something further.

Senator CASE. Nothing more, except I appreciate his coming. I think Mr. Raabe well represents the determination of the people in the area to try to help themselves if they can. This matter of voluntary contributions for a contract of this sort reflects a real determination to try to help themselves.

Senator BIBLE. Right.

Senator CASE. I think it is appropriate for the Government to sponsor a research program that will give them some guidance.

Senator BIBLE. Thank you, Senator Case.

Thank you very much, Mr. Raabe.

Our next witness is Mr. John C. Camp, of Jasper, Fla.

You have a prepared statement, Mr. Camp?

Mr. CAMP. Yes, sir; I submitted one.

STATEMENT OF JOHN C. CAMP, JASPER, FLA.

Mr. CAMP. Mr. Chairman, gentlemen of the committee, my name is John C. Camp and I live in Jasper, Fla., where I am engaged in the following occupations: Growing southern pine timber, manufacture of lumber, producer of pulpwood, and gum naval stores.

I served as president of Citizens Water Conservation Association, a nonprofit corporation, during which time beginning June 28, 1955, 18 counties in north Florida, joined by 3 counties in south Georgia, participated in a contract with a firm specializing in rain increasing through the use of private weather forecast and silver iodide generators for a period of 1 year. The above association was organized

after our area had suffered several years of severe drought, with lakes and streams many feet below normal, the subterranean watertable as much as 20 feet below normal, and with long-range weather predictions forecasting no relief.

The money to finance this project was raised among landowners of all sizes in the area served. At the end of the 1-year period a large majority of those subscribers who had kept themselves informed of the project were satisfied that they made a wise investment; however, because of the many small owners within the area, and failure on their part to keep informed of the work done and the results obtained, our association was unable to raise sufficient funds to continue the project for the second year.

Senator BIBLE. Are you doing anything in this year?

Mr. CAMP. I think I covered that when I said we were unable to raise sufficient funds.

Senator BIBLE. I understood your first year was 1955–56.

Mr. CAMP. Yes, sir.

Senator BIBLE. Then you had 1956–57.

Mr. CAMP. We were not able to continue.

Senator BIBLE. You didn't continue 1956–57? How about 1957–58; are you doing anything toward that?

Mr. CAMP. No, sir. We still have some funds that we retained in the event that we can educate the people to the project. We have had good cooperation from the small landowners where the sum paid in was negligible.

Senator BIBLE. Was this on an acreage basis?

Mr. CAMP. Yes, sir.

Senator BIBLE. Was it 2 cents or 3 cents an acre?

Mr. CAMP. We used 2½ cents an acre to raise the funds to support this project. I believe we had about 13 million acres.

Senator BIBLE. Thirteen million acres?

Mr. CAMP. Yes, sir.

Senator BIBLE. How much is that in money multiplied out by 2½ cents?

Mr. CAMP. Well, the cost of the contract was a little less than $70,000 for 1 year. We had a lot of nonparticipants in the financing.

Senator BIBLE. I appreciate that. But the total cost of the project was approximately $70,000?

Mr. CAMP. I believe, approximately. I believe it was nine-tenths of a cent an acre, actually, that was the cost of the project. I believe that it correct. However, we had to do like the others, we had to assess the willing a little heavier to carry the unwilling.

Any other questions?

Senator BIBLE. No; you may proceed.

Mr. CAMP. With the increased demand upon our underground supply of water, from both industry and modern farming practices using irrigation, and realizing that we are presently drawing on a reservoir of water stored by nature over the centuries, it has become imperative that sound methods be encouraged to replenish the rapidly diminishing underground water supply with which we were endowed, and at the same time bring much needed rain for our growing crops. Florida particularly has suffered in this respect, and its citizens are becoming increasingly aware that greater effort must be made to both increase

our fresh water supply and conserve that supply which yet remains.

In general, the rural areas of the southeastern section of this Nation depend upon farming and forestry to provide the foundation for their livelihood and economy, particularly in my section is this true. The people of this section are presently suffering an economic depression because of drought which has brought about crop failures for the small family-size farmers who cannot afford costly irrigation, devastating forest fires, reduced growth in forest, forest pest invasions which are taking a heavy toll of both young and mature timber. Because our economy is securely tied to these products of the soil, we must develop some means of providing additional rainfall upon which these products so vitally depend. As an example of the seriousness of this condition to us, in my section, though Florida has led the eastern part of our Nation in population gain during recent years, our own section of the State has suffered a declining population.

In closing, may I strongly urge that this committee report Senate bill 86 favorably, in order that further experimentation and participations in weather modification may be made more available to cooperators in all of the 48 States. Science has made great progress in this field, and certainly it will succeed in bringing relief to this vital segment of our economy if properly encouraged and assisted.

Secondly, may I urge this committee to retain this program under the present Advisory Committee on Weather Control who have a background of nearly 3 years in this work; and, further, that this committee recommend that the knowledge of private scientists accumulated during the past 10 years in the field of weather modification be drawn upon for the benefit of the entire Nation.

That concludes my testimony unless there are some questions.

Senator BIBLE. Thank you very much. I have no questions. We appreciate your coming here and giving us the benefit of your views.

Mr. CAMP. Thank you, sir.

Senator BIBLE. Thank you, sir.

The next witness is Mr. Dave Grasmick, president of the North Platte Valley Hail Suppression, Inc., South Morrill, Nebr.

Do you have a prepared statement?

Mr. GRASMICK. I have three copies, Mr. Chairman.

Senator BIBLE. If we might have a couple of those. Then you may proceed.

STATEMENT OF DAVE GRASMICK, CHAIRMAN, NORTH PLATTE VALLEY HAIL SUPPRESSION, INC.

Mr. GRASMICK. Mr. Chairman and members, my name is Dave Grasmick, from Morrill, Nebr. I am the chairman of the North Platte Valley Hail Suppression, Inc., in western Nebraska. We are a nonprofit association of farmers, ranchers, businessmen, and landowners in the Scottsbluff area of Nebraska.

Because of the urgency of the problem, the great economic benefits to be derived from a hail suppression program, both to our own area and that of our Nation, our association strongly urges the passage of Senate bill 86 as written.

We believe those voluntary individual and group supporters of private weather modification projects, as well as the operators over

the past 10 years, have a definite interest in, and have contributed extensively to, the orderly development of this science. Therefore, it would seem any Federal funds should show some actual application to those areas of support prior to being allocated to other areas. Truly it would be a sad situation if the pioneers—such as our North Platte Valley project, which has been carried on for the past 4 years, were overlooked, and the benefits of these funds revert to those of lesser interests.

We are of the opinion that the Advisory Committee on Weather Control, having three or more exhaustive years devoted to the specialized attention of field operational programs in this country, are more capable to administer this appropriation than some group or groups primarily interested in further laboratory or decentralized and nonrelated numerous small research projects.

We are of the opinion that it is also vitally important that the orderly progress of the past 10 years not be interrupted, or rechanneled into programs of no immediate or future payoff.

Senator BIBLE. What do you mean by "future"? What does the use of that particular language mean, Mr. Grasmick?

Mr. GRASMICK. What we have in mind is we feel definitely that the money, a good portion of the money, should be spent in field operation. We have a general feeling that if it was all handled through laboratories there would be no future payoff. In other words, we don't think that the money would be well spent to accomplish the things that might be accomplished if it was spent in field research.

Senator CASE. You are not excluding the laboratory work, but you want some of both?

Mr. GRASMICK. Yes; we definitely feel that laboratories must be in operation; but we definitely feel that there is great value in actual field research.

Senator BIBLE. You should have both the basic research and applied research?

Mr. GRASMICK. That is right.

Senator BIBLE. Thank you.

Mr. GRASMICK. Our people in the North Platte Valley have paid for our programs for the past 5 years in excess of $300,000, all such funds the result of individual voluntary contributions.

Senator BIBLE. Is that on an acreage basis, 2, 3, 4 cents an acre?

Mr. GRASMICK. We suggest an acreage fee but we don't hold anybody to it. In other words, some people can pay more than others, but it is based sort of on the acreage basis.

This is a concrete demonstration of the belief that our group has been convinced there are concrete benefits attached to this work and the progression of this science will be of immeasurable value to all.

Our area represents the area of highest hail incidence and damage of any comparable spot in the United States. The advantages of continued operational research to further improve techniques and understanding of the atmospheric physics involved as such is a vital and necessary program. We are certain more rapid advances through additional funds could be achieved and the disastrous ravages of sudden poverty brought about by one hailstorm may, in the future, be eliminated. We, in our valley, have millions invested, we work diligently year around, and all this effort is too often completely devastated by one hailstorm of perhaps 15 minutes' duration.

The evaluation of our results to date, as computed by the Great Western Sugar Co., reflects the following:

(*a*) The year prior to starting hail operations our damage amounted to 80.1 percent loss.

(*b*) The years of operation, beginning in 1953 through 1956, our damages were in the range of 40 percent—with the exception of 1955 which was higher primarily due to only partial period operations.

Senator BIBLE. I am wondering if you could describe for the record how do you work a hail-suppression program?

Mr. GRASMICK. First, we solicit the money and then contract with a private weather modification firm.

Senator BIBLE. What do they do specifically, is it a ground seeding operation?

Mr. GRASMICK. They do both. In our project we use both the ground generator system and aircraft, as well. Our contractors have set up radar equipment and all modern equipment available so that they can spot these hailstorms as far away as 90 miles. Then they go into action releasing their silver iodide through generators or aircraft, and get it up into the air, these two ways.

Senator BIBLE. After you get it up in the air what happens to the hail? Does it turn into rain or snow, or is it dissipated?

Mr. GRASMICK. I cannot answer that question, Mr. Chairman, because that is simply out of my field. I don't understand the techniques of weather modification or cloud seeding.

Senator BIBLE. I didn't want to get technical, but if the hailstorm is coming in and you have this silver iodide treatment from the ground and from the sky, what happens to the prospective hailstorm? Does it avoid your area or turn into rain?

Mr. GRASMICK. No; it turns to rain.

Senator BIBLE. It turns to rain?

Mr. GRASMICK. What it does is, "feathers"—from observation as a rancher.

Senator BIBLE. Yes.

Mr. GRASMICK. Take the thunder cloud, and we know hail clouds when we see them, it will just smooth them down to a smoother cloud and as a rule we get gentle rain.

Senator BIBLE. Where you had 80 percent, as I understand you, damage in the year prior to the initiation of this hail-suppression program, you cut down the actual damage to something like 40 percent up to last year?

Mr. GRASMICK. That is right.

Senator BIBLE. Last year you had a little higher percentage because you only used the hail-suppression program periodically?

Mr. GRASMICK. That is right. We went about halfway through the hail season which consists of about 115 days in the growing season. We ran out of money and we had no other way to continue, and running out of money stops me quicker than anything in the world, you know. We just had to amend our program and the result was we had hail as late as the 25th of September when the crops were at their very best bloom and practically fully developed and the crops were completely wiped out.

Senator BIBLE. I understand your statement to say, Mr. Grasmick, that you favor S. 86?

Mr. GRASMICK. Very much.

Senator BIBLE. You think the program should go forward?

Mr. GRASMICK. Very much.

Senator BIBLE. You think it should go forward on the laboratory level?

Mr. GRASMICK. That is right.

Senator BIBLE. But you also think it should go forward in the field?

Mr. GRASMICK. That is right.

Senator BIBLE. And as techniques are improved, and as the science becomes more proficient, that some of the field enterprises should inure to the North Platte Valley, around Scottsbluff, when you already have pioneered it for 4 or 5 years?

Mr. GRASMICK. Very much. We are going into our fifth year.

I may further add that the evaluation reports that the Great Western Sugar Co. has are now in the hands of your weather modification people here in Washington.

I may further say, too, that the Great Western Sugar Co. has without a doubt the best record on hail damage of anything in the United States. Because they have records of hailstorms dating back 21 years. And so we tremendously rely upon their evaluation of such a program, plus the fact we didn't have hail.

Senator BIBLE. How big do the hailstones get in North Platte?

Mr. GRASMICK. I would be very happy to show you these pictures that were taken 3 miles west of my farm at Morrill.

Senator BIBLE. Very glad to see them.

Mr. GRASMICK. In the foreground—these are California oranges. They are either small oranges, or we have big hailstones. [Laughter.]

Senator BIBLE. I think the record can show that you have big hailstones. Boy, they are big. They are a good-sized snowball.

Mr. GRASMICK. They not only cause crop damage; they have killed livestock and knocked the roofs off buildings, and have done millions of dollars' worth of property damage in addition to livestock and crop damages.

Senator BIBLE. When they hit the ground, are they practically solid ice?

Mr. GRASMICK. Yes. Actually, most of the time these hailstones have sharp edges on them. So, we would advise you never to get caught in one.

Senator BIBLE. We have hailstorms every once in a while out our way, but I am willing to concede ours to you. We are very happy not to try to outdo you. Can we have some of these for the record?

Mr. GRASMICK. You may have them all.

Senator BIBLE. I think it would be helpful if these may be made part of the record by reference, because I do think they point up the tremendous size of the hailstones. It gives the committee a graphic illustration of the problem you have there. Thank you very much for the very vivid picture of the problem that you have in Nebraska.

Senator Case?

Senator CASE. I want to compliment Mr. Grasmick and his associates on the initiative they have shown, and express my personal appreciation of the statement.

One thing I have been interested in, in Mr. Grasmick's presentation, as well as many of these others that have appeared. Some have had prepared statements, but when you ask them questions they go right on

with perhaps as effective and perhaps even more effective answers than the prepared statement. They have done a very good job.

Senator BIBLE. They know their subject.

Mr. GRASMICK. Thank you. I appreciate the privilege of appearing here. I want to thank each and every one of you.

Senator BIBLE. Thank you very much.

Our next witness is Mr. Wallace E. Howell, president, Wallace E. Howell Associates, Lexington, Mass.

Dr. Howell, very happy to have you with us.

Dr. HOWELL. Thank you very much, Mr. Chairman and members of the committee.

STATEMENT OF DR. WALLACE E. HOWELL, PRESIDENT, WALLACE E. HOWELL ASSOCIATES, LEXINGTON, MASS.

Dr. HOWELL. I think I will use my prepared statement as an outline and vary it or fill it in somewhat.

Senator BIBLE. You may feel at liberty to do so. I think we are very aware of the problem, both in the field of hail suppression, as just testified to, and in the case of cloud seeding, where there is need for more rain from the various presentations that are made. If you will rather pinpoint your observations as to the bill that is before us, and what we can do to be of further assistance in tying up these various loose ends.

Dr. HOWELL. When I came here this morning, Senator, I thought I was going to talk about this bill without speaking either for or against.

Senator CASE. Before you start, I wonder if you would read your first paragraph? I would like to have those present identify you.

Senator BIBLE. I didn't mean to foreclose you from reading your statement. You may read it all or part, as you see fit.

Dr. HOWELL. My name is Wallace E. Howell, and I am a meteorologist by profession. For the past 6 years I have been engaged in weather-modification activities on a commercial basis. Before that time I was a research associate at Harvard University, investigating the physics of clouds. My commercial work in weather modification has included projects for industrial clients in the United States, Canada, Puerto Rico, and Latin America.

From my point of view, the need for Federal legislation on weather control is limited to two concerns: First, the orderly accumulation and evaluation of information about weather control that will serve to guide future public policy; and, second, the carrying out of certain experiments which only a public agency, for legal or policy reasons, is qualified to undertake. I do not believe that Federal legislation should go beyond these two purposes at this time.

There is no danger that scientific or commercial progress in weather modification will cease for lack of Federal snpport. From our experience with more than a score of industrial clients, we know that the advantages of weather modification are attractive enough to hold and expand the interest of the industries concerned.

Here I would like to amplify a little bit to say specifically what the kind of advantage that we have been able to show, which holds this interest, is. Specifically, over a large number of operations, a wide

variety of climatic areas, these increases in precipitation have averaged approximately 20 to 25 percent above the amount that would have been expected otherwise.

Senator BIBLE. Will you give that last statement again? I didn't know that I thoroughly understand it.

Dr. HOWELL. About 20 to 25 percent precipitation above what would have been expected to occur without the seeding.

Senator BIBLE. I am surprised at that high a percentage. I think at our first hearing the testimony from the people on the western slope of the Sierra Nevada indicated it was somewhere in the neighborhood of 9 or 10 percent.

Dr. HOWELL. Nine or 10 percent, I think, was indicated in the earlier reports. I think, in the later reports of the committee that I have recieved, they indicate somewhat higher percentages. I don't feel that it makes too much difference whether it is 9 or 10, as against 20 to 25. The point is, it is not 1 to 4.

Senator BIBLE. It is a substantial amount.

Dr. HOWELL. It is a substantial amount.

Senator BIBLE. Very well. You may proceed.

Senator CASE. And on how broad a scope would you apply your observations?

Dr. HOWELL. Senator Case, my basis for that statement is a series of evaluation reports that have been prepared in our office for our clients covering, in the first instance, 13 cases where we have operated, for the first time, in a zone and made an evaluation by examining past records, establishing from these records the relationship between rainfall in the target and the rainfall in a nearby control zone.

Senator CASE. Have they been mountainous areas, the Great Plains, or——

Dr. HOWELL. We have not worked in areas that would be classified under the work of the Weather Control Committee as mountainous or orographic zones. We have worked under what they would call semiorographic and nonorographic.

Senator BIBLE. What is orographic, for the purpose of the record?

Dr. HOWELL. That is determined primarily by the mountainous character of the terrain.

Senator BIBLE. Will you proceed.

Dr. HOWELL. Using the period of past records to obtain a statistical forecast of the most likely amount of precipitation in the target area to have occurred in conjunction with the measured amount in the control area, giving this as the then expression of the most likely amount of precipitation without seeding, and that can be expressed with a definite probability of occurrence, with a definite probable error.

In these 13 instances where we made this kind of study for the first time, after a first period of operation we obtained indication of 24.2 percent increase in the average of those 13. In subsequent operations over the same target, using the same rules of the game for evaluation where we had already determined upon the control zone and already determined upon the period of record that was to be used for the evaluation, we have evaluated 30 subsequent operations in these same 13 zones. The average increase of these 30 subsequent operations was 24.6 percent increase, where we were then following established rules of the game, you might say.

Now, I recognize that these reports are not made by a disinterested agency, but I do not feel that they have been made by an incompetent agency. They have been on file with the Committee, they have been available to all members of the Committee.

Senator BIBLE. By "Committee," you mean the Advisory Committee?

Dr. HOWELL. The Advisory Committee on Weather Control.

Senator BIBLE. Thank you.

Dr. HOWELL. And they have not been publicly challenged.

Well, I won't say they have not been publicly challenged in their individual character. Obviously, the testimony today has challenged the general conclusion.

I am certain that the results of this commercial work will continue to justify this interest and will continue, as it has in the past, without Federal action, to challenge those who have cast exaggerated doubts upon the practicability of weather modification. If I were to defend these statements in detail I would have to go through so many reports it would take many days of the committee's time.

But I would like to point out that these general character of results have been substantiated by results from such diverse sources as Australia, Japan, Mexico, and other commercial seeders; also Africa.

In view of these results I am beginning to feel, as far as the testimony of those who claim that there have yet been no substantially proven results, that they are all out of step but Jim.

As for scientific progress, weather control owes so much to so many diverse fields of science that a strong policy on and vigorous support for basic scientific research as a whole is more appropriate at this stage in its development than would be legislation focused upon weather control alone. Certainly the possibilities that have been opened up by weather modification should serve as only one of the many illustrations of the need for a truly adequate program of basic research in the physical sciences to be maintained through an organization such as the National Science Foundation.

I believe that there are, however, some important ends that can be served only by legislation of the sort considered here. Here I go back to an earlier paragraph to point out that the two concerns which I feel are appropriate are the orderly accumulation and evaluation of information about weather control, and certain experiments which it is in their nature that only a public agency can carry out.

Senator BIBLE. You have in mind there the tornado situation?

Dr. HOWELL. That is right.

Senator BIBLE. And the fog removal of an airport, possibly, something of that kind, on a large scale?

Dr. HOWELL. Experiments that involve sort of the concept of eminent domain where you are making operations that obviously must influence a great many diverse interests, a great many diverse people who do not necessarily agree that it is all to their individual advantages.

Senator BIBLE. Thank you.

Dr. HOWELL. But one thing seems to me certain: If I am right and rainmaking has reached a practicable stage of feasibility, then it is not appropriate to have this go into basic research alone under the National Science Foundation. We then need something else in applied research on which to establish public policy on weather control.

But whether I am right or wrong there is still every justification for a strong basic research program by the National Science Foundation which has got to include weather control to the degree that basic research in that is found appropriate anyway.

One of the ends that can be served only by legislation of the sort we are considering is the establishment of the factual basis for future public policy on weather control. Now, this task involves much more than simply receiving and recording data, since the crux of the problem is to establish facts that are not necessarily self-evident and that may indeed require the highest order of perseverance and ingenuity in order to uncover them. This, in my mind, is where the need is for applied research as distinct from the basic research which is the proper realm of the National Science Foundation.

Much has been made by certain entities of their qualifications for this work in that they are objective and unbiased regarding the so-called controversial aspects of weather control. I would like to point out that it was not objectivity that made Edison a great inventor; it was enthusiasm, persistence, and skill. We may test his success objectively, but there would have been nothing to test but for these other qualities. Nor is it likely that success in the kind of evaluating that will point the way toward a wise public policy for weather modification will crown the efforts of a man or an organization whose chief qualification is objectivity.

I believe it is wise, therefore, to put this matter in the hands of an organization that has shown both a responsible attitude and genuine enthusiasm toward its task. In my opinion, the Advisory Committee on Weather Control has shown itself outstanding in this regard, in gratifying contrast to the performance of the majority of other Government agencies that have operated in this field. I believe also that the character of this agency, being guided jointly by Government and non-Government advisers, has contributed materially to this performance.

In this question of who should carry on the work I would like to comment on the testimony given here previously by Dr. Reichelderfer and Dr. Waterman, who, I believe, and it is my opinion only, would be working from false premises if they established a research program based on the idea that current techniques in weather modification are ineffective.

Nor do I think the damage stops here. For those who have built research organizations in some of the universities and other establishments very considerably through public support, through contract research for the Armed Forces and Weather Bureau and others, are not likely to depart radically from the official line in their findings if they hope to continue to have this kind of support for their organizations.

In this way I think the harm done by the presumption of a false premise can be carried further down the line and become quite a vicious influence.

Senator BIBLE. You think that the present bill puts this responsibility for authorization and direction in the correct committee, in the Advisory Committee on Weather Control?

Dr. HOWELL. I certainly do.

Another instance where an established policy seems to be unwarranted is in relation to statements made about cloud seeding in the

tropics. The scientific viewpoint, as it was expressed on the charts this morning, as it has been expressed by several scientists, is that for teachnical reasons stimulation by silver iodide in the tropics is useless.

We have operated for 6 years in Cuba, and we believe that we have very good evidence to the contrary, evidence that never would have been accumulated by an organization which accepted the premise that for obvious scientific reasons this was impossible.

The impossible on that basis has happened. Furthermore, by continuing to centralize the Government interest in weather modification in the hands of this committee its program can be given continuity and breadth of viewpoint that, in my opinion, would best serve both the needs of other Government agencies and the public interest as a whole.

I think that the committee has made great progress in starting out, I will grant, from quite a lot of hit-or-miss kind of operation done by a number of agencies for a number of sponsors for a number of different purposes.

And to start it from this basis, it has started to bring order out of it. I think it would be unwise to stop this progress toward order which has only nicely begun.

I appreciate Captain Orville's motive in attempting to rescue the experimental research part of the program by sacrificing—or by recommending the sacrifice of the weather-control committee. But I think it would be just that, and I think it would be a very unwise sacrifice.

I do not think, even, that Captain Orville's statement is a freely expressed opinion of the committee as a whole. Certainly, I believe, that the powers given to this committee or to whatever agency is finally judged appropriate to take its place, should be the power and responsibility for carrying out certain experimental researches in weather control.

The reason for this is that the atmosphere, as a laboratory and proving ground for weather-modification experiments, is very much in the public domain, and many experiments that should be undertaken cannot very well be accomplished without the exercise of a sort of power of eminent domain. I believe that the committee or its successor should be granted sufficient funds so that it can carry on a reasonable amount of research on its own initiative, and subject to its own standards.

Also, I think that this should not be limited to the continental United States, to the States, but should include Territories and possessions and the Commonwealth of Puerto Rico.

Perhaps the scale of operation envisaged by the recommendation of S. 86 to appropriate $5 million for this purpose is not excessive. When I wrote this, it looked larger to me than it does as I speak now. I think now it is entirely reasonable.

In closing I would like to thank the committee very much for this opportunity to express my opinions.

Senator BIBLE. I very much appreciate your positive statement, Dr. Howell. I think I have no questions. Senator Case?

Senator CASE. Just one brief question. Dr. Howell, what did you use for your base when you spoke of 20 to 25 percent increase? Was it a historical base? Was it as compared with the same area under

different conditions, or was it against similar areas that were not seeded?

Dr. HOWELL. Let me take a typical instance of this, Senator Case. Maybe it is easier to deal in concretes.

We have worked for 6 years on the watershed in Canada, above Lake St. John. We have about 15 years of record going back before the time we were operating from which we were able to establish a relationship between the monthly precipitation in the Lake St. John Basin and the monthly precipitation in areas around it outside of the zone of seeding.

By expressing this relationship in a statistical manner, we can now predict from any given amount of precipitation in any given month in the control areas what the precipitation in the target area will be and express that prediction in terms of a certain probable error of the prediction.

Now, if the occurrence differs from the prediction by an amount which is significant in this scale of probable error, we feel that we have an indication that seeding has had an influence.

In the latest evaluation covering the seeding period from June through December of 1956, on that basis we obtained an indicated increase of 24 percent over the amount predicted by this statistical relationship, and this was nearly 3 times the standard deviation of the forecast.

Senator CASE. What is the purpose of your target seeding?

Dr. HOWELL. The purpose is to increase the water supply for the generation of hydroelectric power in the plants of the Aluminum Company of Canada.

Senator CASE. Are you employed then by the Aluminum Company of Canada?

Dr. HOWELL. That is correct.

Senator CASE. They pay the bill?

Dr. HOWELL. That is right.

Senator CASE. How long have they been paying the bill?

Dr. HOWELL. Ever since the beginning of the project.

Senator CASE. Six years?

Dr. HOWELL. Six years.

Senator CASE. Do you still have a contract with them?

Dr. HOWELL. We do.

Senator BIBLE. Thank you very much, Doctor. We appreciate your testimony.

Our next witness is Mr. Ivan Johnson of the State of Nebraska. Mr. Johnson? He is not here. I am wondering if he has a prepared statement. Is there someone speaking on his behalf?

FROM THE FLOOR. I am advised there is no statement on file.

Senator BIBLE. Our next witness is Mr. Swackhamer.

Mr. SWACKHAMER. I have a short prepared statement.

Senator BIBLE. Glad to receive your testimony, Mr. Swackhamer.

STATEMENT OF O. C. SWACKHAMER, PRESIDENT, IOWA & MISSOURI WEATHER MODIFICATION CORP.

Mr. SWACKHAMER. Mr. Chairman, I am O. C. Swackhamer, president of the Iowa & Missouri Weather Modification Corp., also president of the Midwest Livestock Feeders Association.

The weather modification area covers 3 counties in Missouri and 8 counties in southwest Iowa. We entered into a cloud-seeding project on June 8, 1956, after an exceptionally dry spring. The majority of the area came out with a fair crop. We have contributed some of the success to cloud seeding.

I might say in that respect that the experimental farm of the Iowa State College, which is near the center of the target area, we had one-half inch of available moisture in the top 5 feet of soil April 1, 1956. Today we have approximately 6 inches of available moisture in the top after almost a year of cloud seeding.

We would like very much to see S. 86 passed and a continuation of the President's Advisory Committee on weather modification. We would be very interested in seeing field research on the value of cloud seeding in our Midwest area. Now that we have improved seed and learned to use fertilizer, the limiting factor of economical production is water.

There has been considerable discussion here today on research in the laboratory and research in the field. I certainly realize that laboratory and technical research is very, very important, but we get our rain out of the clouds that are out over the field and we certainly would like to see field research carried on in connection with laboratory research.

If for a few cents per acre through cloud seeding, we can increase our rainfall, great progress could be made in crop and livestock production in our area where it can be done on an economical basis.

Very important to agriculture and business in our area is weather forecasting, both long range and current.

With the assistance of Federal funds and field research in cooperation with our State colleges, we can learn much and improve our forecasting service. I had the privilege recently of being in a meeting in which we had the meteorologists and climatologists from four land grant colleges, Missouri, Iowa, Nebraska, and Kansas.

You have some young men in those colleges who are meteorologists now that would contribute a lot if they were directed and some funds were available. They don't all have to work on the same projects. It has been suggested here a regional division, and that particular region has approximately the same weather setup for the 12-month period and that region could be used for some research.

And right now is a golden opportunity for some research. There is the Spencer, Iowa, area, which is in northern Iowa. Then you drop down and make a skip of about 2 or 3 counties, then there is the Shenandoah area, the IMO area and then you drop down and there is the St. Joseph area. That makes an ideal situation for research. Because right across the river you have weather that is exactly the same, you have exactly the same weather on the east, north, and south, with skipping areas between, which makes it an ideal evaluation project.

We would look forward to the day when we can have accurate long-range forecasting of weather. This is a service which we have not had in the past, but with additional research, we feel that this can be a reality. We feel that more rapid progress will be made through private companies under the supervision of the Advisory Committee

than through the United States Weather Bureau. We base this on the fact that we have seen more modern equipment and more accurate forecasts from commercial companies than through the United States Weather Bureau.

Our people of northwest Missouri and southwest Iowa urge passage of S. 86. Thank you.

Senator BIBLE. We very much appreciate your statement, Mr. Swackhamer. Senator Case?

Senator CASE. You wouldn't object to some more modern equipment being provided for the Weather Bureau?

Mr. SWACKHAMER. I certainly wouldn't object to more modern equipment for anything that will improve our forecasting service. As you know in agriculture we are very dependent on weather.

Senator CASE. How long have you been in the cattle-feeding business?

Mr. SWACKHAMER. I have been in the cattle-feeding business approximately 20 years.

Senator CASE. Do you recall when the Weather Bureau was in the Department of Agriculture?

Mr. SWACKHAMER. I do.

Senator CASE. Have you noticed any difference in emphasis or difference in the weather forecasts for their attention to agricultural interests, as between the time when the Weather Bureau was in the Department of Agriculture and when it went to Commerce?

Mr. SWACKHAMER. I can't say that I do. I was probably young enough at that time that I didn't pay as much attention to weather forecasting as I do now.

Senator CASE. I think my question is a little bit unfair or a little leading. What I really had in mind was to bring out the possibility that with the development of aviation, there has been more emphasis upon weather forecasting for purposes of aviation. And I was wondering, however, if you thought that the interests of agriculture perhaps haven't received as much attention as they would have if the weather service had stayed with Agriculture?

Mr. SWACKHAMER. I think possibly that is right. We get a very good weather service from our Weather Services Development Corp., pinpointed to our very area, and it helps us a lot.

We hope to continue our project, starting June 8, 1957, in the mapority of the counties. The St. Joe area will be cooperating and I presume a good part of the Spencer area will be operating.

Senator CASE. Personally I would like to see the Weather Bureau get whatever funds it needs.

Mr. SWACKHAMER. I certainly wouldn't want to cut any funds from the Weather Bureau. The only thing I wouldn't want to do is to see the funds get bottled up so that we wouldn't make the progress that we need to make in cloud seeding and weather modification.

Senator BIBLE. Further questions?

Senator CASE. No.

Senator BIBLE. Thank you very much, Mr. Swackhamer.

Our next witness is Dr. Leopold, United States Department of the Interior, Washington, D. C.

We have been handed your statement, Doctor.

STATEMENT OF DR. LUNA B. LEOPOLD, DEPARTMENT OF THE INTERIOR

Dr. LEOPOLD. Thank you, Mr. Chairman. I am Luna B. Leopold, chief hydraulic engineer of the Geological Survey, representing Assistant Secretary of the Interior, Fred G. Aandahl. I would like, however, before starting in on my prepared statement, and by way of further introduction, to say that I have done field research in cloud modification myself, when I was chief meteorologist for the sugar and pineapple industries in Hawaii, under the auspicies of the two research institutions maintained by those industries, the Pineapple Research Institute of Hawaii and the Hawaiian Sugar Planters Association Experiment Station.

In that regard, therefore, I am not unacquainted with the field of cloud modification.

To begin my prepared statement, if I may, please, Mr. Chairman.

Senator BIBLE. Certainly, you may proceed.

Dr. LEOPOLD. The Federal Government has a very real interest in any and all technical developments which can immediately or potentially increase the amounts or enhance the availability of our water resources. The Department of the Interior has a specific interest in this matter.

The Department is charged with several different kinds of responsibility in the water-resources field. The Geological Survey, a scientific organization, is responsible for the collection of basic records necessary to describe and appraise the Nation's water resources, for analyzing and interpreting these basic records, for geologic and engineering studies in the field of ground water, and for conducting research in hydrology.

The Bureau of Reclamation plans and builds dams to provide reservoir storage for irrigation use, and builds and operates irrigation works of many different kinds.

The Bureau of Land Management administers millions of acres of public land. The principal Federal holdings are in the West, where water is a critical factor. Grazing, which is one of the important uses of the public domain, is highly dependent on natural rainfall.

The Fish and Wildlife Service has an interest in water for the maintenance of wildlife populations and for correlative recreational values.

Only a few of the bureaus in the Department of the Interior having an interest in water are mentioned here. Thus, it can be seen that an important part of the Federal responsibility in the field of water resources rests on this Department. To whatever extent developments in the field of weather control effect the Federal interest, the impact will be great on the work of the Department of the Interior.

By the same token, it is in the Federal interest and of particular concern to this Department that developmental work in the field of weather control be scientifically sound and that the potential importance of that work be evaluated critically. Unwarranted optimism could encourage the public to indulge in wishful thinking which might result in disruption of sound long-range planning for the orderly development of the available water resources.

If I may move from my prepared statement for just a minute. As you probably remember, there have been indications that some people

would have the public believe that it is possible in the near future, perhaps, to consider relying on weather modification techniques rather than reservoir storage in the West. At least this has been seriously proposed by some individuals.

To return again, more than 10 years have passed since the initial announcement by Schaefer and Langmuir of their early experiments. So great was the interest in the possibility of increasing precipitation that the United States Weather Bureau, the Department of Defense, as well as many private institutions and companies, conducted experiments in cloud seeding and pursued research in the field of cloud physics.

Two major difficulties have plagued all field experiments. The first is the lack of suitable physical controls against which the results of cloud inoculation could be compared. In every experiment which showed some indication that rainfall had been caused or increased by the seeding, there always remained the possibility that the rain might have occurred even if the seeding had not been done.

The second difficulty is the inadequacy of our knowledge of the nature of the precipitation processes in clouds. Lacking the detailed knowledge of the physics of raindrop formation under various conditions, it has been difficult to evaluate the differences in action of seeding agents in natural clouds from the actions observed under laboratory conditions. Much remains to be known about the electrical phenomena in clouds which affect the precipitation processes. The type, distribution, and action of natural nuclei need further exploration.

At present the field experiments in which nucleating agents were introduced into natural clouds can be analyzed only by the use of statistical techniques. Some field experiments carried out under conditions of orographic lifting, as pointed out, lifting over mountains, and in favorable synoptic situations have shown small but statistically significant increases in precipitation.

It can be said, however, that whatever increases in precipitation have been observed can be identified only through the use of a detailed statistical analysis. Despite some millions of dollars expended for large-scale field experiments, including Project Cirrus, it is still not possible to say exactly under what conditions rainfall might be increased by artificial inoculation, nor to specify certain quantitative amounts of such increases.

The tests which have been made as well as theoretical considerations prove that under conditions of drought, weather situations conducive to rainfall increases or to rainfall initiation from cloud seeding are more rare than during periods of normal weather. A bill for Federal participation in weather modification studies should, therefore, be written with the idea in mind that cloud seeding probably cannot be considered a practical measure for drought alleviation until further basic data are developed.

If I again may move from the prepared statement. You have heard several witnesses today point out such instances as during a particular month there were no synoptic situations which were amenable to cloud seeding. It is well known to everyone, I think, and as brought out by the witnesses, some of the witnesses previously, the best results usually will be achieved by seeding in synoptic situations where the natural processes are close to making rain anyhow.

Senator BIBLE. What is a layman's definition for synoptic situation?

Dr. LEOPOLD. The current weather situation. You might say the occurrence of clouds, occurrence of front, and the particular airmasses that exist in a particular time and place.

These facts and this history argue strongly for assigning first priority to basic research in cloud physics, including the mechanics of precipitation, the nature and distribution of natural nuclei, and the structure of clouds. Research of the type required is of a long-term and basic nature. The answers required at the present time will not come, as we see it, from continuation in the immediate future of large-scale field experiments in which clouds are seeded—and I am saying for the purpose of making rain, which clouds are seeded—and the results of the seeding are measured. Rather, it appears necessary to concentrate first on basic processes in the atmosphere. At a later stage when more basic knowledge is available, large-scale experiments under statistically controlled conditions will be required. The needed research includes, of course, both studies in the laboratory, theoretical studies, and studies in the atmosphere.

At this point I would like to make some observations on what appears to me to be some confusion in the terms that all of us are using.

In the discussion of some of the witnesses there was the implication that basic research is confined to the laboratory and that applied research is that research which takes place in the atmosphere. That is not necessarily so. At a matter of fact, applied research can, of course, proceed in the laboratory and basic research definitely should proceed under natural conditions as well as laboratory conditions. To give you one example of the kind of project which has been sponsored by the Advisory Committee on Weather Control that I think does indicate—is an example of a type of basic research which is needed.

In the gliding experiments on the coast of Florida, where gliders were used to penetrate clouds and actually collect in counting chambers in the glider the number of nuclei so they could be observed, here you were dealing with a natural laboratory in the cloud itself. This could easily be called basic research. When we speak of basic research, that is in my statement, I am not restricting the research which is necessary to that which has to be carried on in laboratories, but, rather, the differentiation is made here in my statement that we need to know more about what happens in the atmosphere rather than to have large-scale experiments designed primarily to make rain and to determine whether or not we did so. In other words, I would concentrate on a study in the atmosphere and in the laboratory of the mechanics of what happens under conditions of natural clouds and nucleated clouds.

Senator BIBLE. May I clear one point for my own information? Do I understand your position to be that there is doubt in your mind about the beneficial results of cloud seeding?

Dr. LEOPOLD. No, sir; I didn't say that. We are addressing ourselves here to the question of the role of the Federal Government in assisting in the field at this time. We, for example, believe, as brought out by Dr. Howell and others, that the private groups will actually continue to prosecute field operations aimed at actual increases in

precipitation. But when we are dealing with what is the most important role that the Federal Government can play at this time, in my opinion that role is in the sponsorship of those kinds of research which cannot be undertaken by other groups, and that is this is the best place to apply whatever Federal aid the Congress might decide to give the field.

Senator BIBLE. The reason I asked the question was prompted by the last sentence on your first paragraph on the second page, where you said in every experiment which showed some indication rainfall had been caused or increased by the seeding, there always remained the possibility that the rain might have occurred even if the seeding had not been done. I took that to mean that there was some skepticism on your part that the cloud seeding did result in rainfall in these specific areas.

Dr. LEOPOLD. No, sir. What I am trying to bring out is that when rainfall increases are small, we must rely on statistical techniques all of which, as you know, have a probability statement involved. In other words, that there still remains the possibility that the increases which were observed could have occurred by chance. This is inherent in the probability type of analysis.

Senator BIBLE. What do you consider a small increase?

Dr. LEOPOLD. Well, a statistically significant increase, sir. The increase——

Senator BIBLE. Nine or ten percent, is that a significant increase?

Dr. LEOPOLD. You may have 2 or 3 percent increase which is statistically significant. That may be—in other words, I am talking about the difference between a percentage increase in rainfall and a statistically significant increase, if you had enough tests you could detect a very minor percentage increase in the total rain.

Senator BIBLE. I was rather impressed at the first hearing that we had on this particular bill by the testimony from those who operated on both slopes in the Sierra Nevadas in increasing snowpack. It seems to me—and it was largely for private industry, Pacific Gas & Electric and for California Electric Power Co., where they went into the mountains around Bishop on the east side of the Sierra Nevadas, and went down below Donner on the west side. And I thought the testimony was rather conclusive that the cloud seeding there had caused an increased snowpack. What would be your observation as to that? Is there anything wrong with experiments along that line?

Dr. LEOPOLD. No, sir. It is simply that as every scientist that I have heard testify this morning has indicated, we still are never sure, because we don't know the details of what is happening in the cloud. There still remains the possibility that a mere observation that rain did occur or snow did occur might have occurred due to natural causes, and that it still takes a statistical analysis to guarantee ourselves that the chances are that this was done by seeding. And this is the kind of proof that we are relying on, and all the evaluations of the Advisory Committee are based on improved statistical techniques. There is nothing wrong with that, but I am saying that we must use those techniques because of the fact that these controls are difficult to get your hands on.

As brought out in my statement, there are no direct controls which are easily usable.

Senator BIBLE. I think the entire field which we are discussing is one that is most difficult in the first analysis, obviously. I think you recognize that you cannot reduce it to a mathematical certainty, do you?

Dr. LEOPOLD. No, sir; you can't, that is the point.

Senator BIBLE. You may proceed.

Dr. LEOPOLD. Thank you.

Scientists in Government, in universities, and in industry should participate. Such research needs Government support. The possible kinds of research should be weighed and considered by experienced scientists. In our opinion, such a responsibility would be handled most effectively and efficiently by one of the permanent Government agencies rather than by an advisory committee. The committee type of organization is useful for evaluating the status of a field but does not appear to be the best administrative mechanism for administering a long-term research and experimental program of the type which we visualize and recommend.

The Department of the Interior wishes the Congress to give consideration to some Federal support for research in the field of cloud physics. We believe, however, that the administration of such funds as may be appropriated might best be handled by the National Science Foundation, the United States Weather Bureau, or the Department of Agriculture.

That is the end of my statement, sir.

Senator BIBLE. Thank you, doctor.

Do I understand the last conclusion to be that you in general agree with the principles in S. 86, particularly in the field of cloud physics, but you somewhat disagree as to the administration of the funds and the agency that should handle it?

Dr. LEOPOLD. Yes, sir.

Senator BIBLE. Is that what this boils down to?

Dr. LEOPOLD. That is what it boils down to.

Senator BIBLE. Insofar as Interior's position is concerned?

Dr. LEOPOLD. Yes, sir. But I would also like to stress the fact brought out in my testimony that the usefulness of weather modification as a preventative or a solution for the drought problem is not in our opinion yet in sight.

Senator BIBLE. Why is the National Science Foundation or the United States Weather Bureau or the Department of Agriculture better equipped to handle this research program than the Advisory Committee for Weather Control?

Dr. LEOPOLD. Because it seems to me, particularly in the case of the National Science Foundation, what we are recommending, the type of research that we are recommending, being of a basic and applied nature, and something which has to last over a good period of time. Research, you cannot say we are going to get results in a certain period of time. It is our opinion that such research activities are best handled by one of the permanent Government organizations.

Senator BIBLE. That is as to the basic research. How about this experimental work that goes on in the field?

Dr. LEOPOLD. With regard to the basic research which might go on in the atmosphere, this could easily be handled by research contracts under the National Science Foundation, as recommended here. At a

later stage when large-scale experiments where seeded areas are measured or compared against unseeded controls, then you are in an operational phase that the National Science Foundation, as expressed by Dr. Waterman, probably would not care to administer. But the research aspects of it, which I believe are of first priority, might well be handled best by the National Science Foundation.

Senator BIBLE. Senator Case?

Senator CASE. Mr. Chairman, I have no disposition to quarrel with the Department of the Interior over their desire not to take this program, I am a little intrigued by the position that they take in view of the fact that we had rather extensive hearings on the power problem in the Missouri Basin here a week ago. We spent several days in hearings there, and I think Dr. Leopold, weren't you present at some of them?

Dr. LEOPOLD. No, sir, I wasn't.

Senator CASE. In any event, the Department of Interior was represented part of the time.

The power shortage in Montana and the Dakotas, Iowa, Nebraska, and Minnesota, were attributed to the shortage of water in the reservoirs on the main stem of the Missouri River.

As you pointed out in your statement the Bureau of Reclamation, not merely builds dams to provide reservoir storage but it operates irrigation works of many different kinds and it also sells the power which is generated in the Army-built dams.

Dr. LEOPOLD. May I explain our position on that, Senator Case.

The kind of investigation which we think is necessary must be, as brought out by all of the people whom you have heard today, must be carried on and administered by competent scientists.

At the present time, the Department of Interior does not have a meteorological arm. I would seem unwise for us to compete with universities, with the Weather Bureau, with the Defense Department, and those organizations both public and nonpublic, who by the very nature of their work are meteorological or have a meteorological arm, if we were to go into this——

Senator CASE. I am glad to have you clarify that. You are interested in the outcome of the research.

Dr. LEOPOLD. Indeed we are. That is what the initial part of my statement was meant to convey. But as I say, were we to take it on, we would then have to compete in this field of the great shortage of qualified scientists with those people, or those organizations whose main work is meteorlogical or which have a meteorological arm, as for example, the Defense Department.

Senator CASE. Supplementing what the Chairman has said with respect to one of the witnesses in the earlier hearings, Mr. Thomas J. Henderson, the chief hydrographer for the California Electric Power Co., testified that he had been connected with the weather modification program of the California Power Co. since its beginning on February 2, 1948, which he thought was the longest continuous experimental cloud seeding in the world, and they have been working on this small target area of 30 square miles on the eastern side of the Sierra Nevadas.

The first 3 years of the program were analyzed by the United States Weather Bureau and the results published by the Department of Commerce in Research Paper No. 36, he testified.

Then he further said:

The analysis that the United States Weather Bureau made of the first 3 years of the operation indicated a 9-percent average annual increase in those 3 years, and they have not publicly brought that analysis up to date in the rest of the years following those first 3 years, but we looked at it, and the results looked about the same to us.

Senator BIBLE asked them:

Do you believe that is an overall safe figure, as to seed modification over a period of 9 years? You have increased the rainfall snow pack by approximately 9 percent.

Mr. HENDERSON. Well the analysis was figured in terms of annual streamflow instead of snow pack, but that is the figure that applies to streamflow, and I think that is a pretty good average annual figure.

Which I thought was rather interesting since their whole purpose was just the increase in water for the generation of power which is related to the work of the Department of the Interior.

Dr. LEOPOLD. It is for this reason why you can see why we have a definite interest in what progress is being made, and that is why we want to give support to Federal help in this field. But we do not feel that the Department of the Interior should take on the responsibility in competition with those other agencies which have meteorological arms.

Senator CASE. I think we have that pretty well established and clearly established now. There was one sentence in your statement I would like to read, and ask a question about. Near the top of page 2 or at the end of the first paragraph on page 2 you said—

in every experiment which showed some indication that rainfall had been caused or increased by seeding, there always remained the possibility that the rain might have occurred even if the seeding had not been done.

I suppose that technically you could say that in every instance, where you seed a cloud, the possibility exists that the cloud might produce rain on its own. But a casual or quick reading of that might suggest that you were implying that the probability rested with nature having done it.

Dr. LEOPOLD. No; I don't mean to necessarily imply that, Senator Case. But, rather, that were the results so spectacular and were all experiments to show the same kinds of results, then one could say without statistical analysis it is quite obvious that this is a cause-and-effect relationship.

However, what happens is that only a portion of the experiments show statistically significant results. Some show no statistical significance when comparisons are made and all have to rely on some sort of statistical techniques in order to come to some quantatitive measure of the validity of the conclusion which is drawn.

That is all that is meant.

Senator CASE. Where direct seeding is used by airplane and the operator flies over a mass of clouds and seeds a particular cloud area, and that is the area which builds up and which eventually lets go with some precipitation, would you not concede that the probability is that it would not have rained had he not operated on that cloud?

Dr. LEOPOLD. Senator Case, those of us who have actually done this in the field recognize that there still remains some doubt, and this really is the problem that we face.

Only by having a sufficiently continuous set of experiments under fairly well controlled conditions can we say with any assurance what kind of an effect we have.

In the experiments that I ran in Hawii, we had exactly the kind of a problem which you have just posed. This was a question of dry-ice seeding in cumulus clouds. We flew into those clouds which looked most active—those were the ones which, had we not flown into, probably might have increased in height naturally.

We presented our conclusions to the people who were supporting our research, these sugar and pineapple people, pointed out to them that the results looked interesting. We could not prove to our own satisfaction as scientists that the results that we saw, which from the lay standpoint looked very convincing, as scientists we were not convinced in our own minds that we had proven one thing or another.

And the experience that we had there, it seems to me, telescoped into one small experience all the kinds of things that we are discussing here.

The commercial operators who are sponsoring this didn't want any more research, they wanted to start in immediately and make rainfall for themselves, because they felt it was proven.

We, as scientists, who ran the experiment, said we were not convinced, that we thought a long period of field research was necessary before we could convince ourselves.

It was the overoptimism actually of the people who wanted immediate increases in rain that actually resulted in the ending of the research under those conditions.

So that my answer under the condition that you cited was "I don't know." It looked very interesting but I wasn't sure.

Senator CASE. It is interesting to a layman, though, to have testimony that when they go over a bank of clouds and the area that is seeded is the one that gets active——

Dr. LEOPOLD. Certainly, it is interesting to the scientist, too.

Senator CASE. And the balance of the area doesn't.

Dr. LEOPOLD. Yes, sir.

Senator CASE. In any event, Mr. Chairman, I think Dr. Leopold has clarified the statement, and has added to the general evidence we have had that a program of research is needed, and that we need to know more about the whole field.

Senator BIBLE. Thank you, Senator Case.

Just one further question, Dr. Leopold. Section 2 of S. 86, I am sure, as you know, says the experimental research program authorized by this act shall be carried on by contracts between the Advisory Committee on Weather Control, and private or public agencies and through cooperative programs with State agencies including land-grand colleges or other State agencies to be designated by the Governor of the State.

It occurred to me that section 2 very largely dovetails with the latter part of your statement where you suggest that we call upon scientists in Government, in universities, and in industry and that research does need Government support, that it should be weighed and considered by experienced scientists.

Apparently, the only place where S. 86 breaks away from your thinking is that you feel that S. 86 could be handled more effectively by a permanent Government agency rather than by the Advisory Committee; isn't that about the only point of difference?

Dr. LEOPOLD. That is correct, sir, but with one exception and that is the reference to drought alleviation.

Senator BIBLE. And that more emphasis be placed upon basic research; is that correct?

Dr. LEOPOLD. That is correct.

Senator BIBLE. I just wanted to clarify your viewpoint in that respect, because it seems to me it boils down—that that is just what the Interior Department report said.

Senator CASE. If you will indulge me further.

Senator BIBLE. Certainly.

Senator CASE. The section to which you called attention I might say was more or less prompted by the way in which the Division of the Department of Interior assigned to the desalination program works. What we had in mind there was to create authority for the doing exactly what Interior does in contracts to research organizations, both private and public, for methods of getting the salt out of water.

Dr. LEOPOLD. I agree that a way of incorporating Government scientists, university scientists, and private groups into the research program is an essential part of whatever legislation is passed.

You are familiar with the program carried on by Interior through Mr. Jenkins.

Dr. LEOPOLD. Yes, sir.

Senator CASE. Mr. Jenkins, I know, has given contracts to universities and to private corporations. I went with a group of Congressmen and Mr. Jenkins up to Boston here a couple of years ago, to see some work being undertaken there by contracts with private corporations interested in research.

Senator BIBLE. Thank you, Senator Case.

Thank you, Dr. Leopold, for your contribution.

Dr. LEOPOLD. Thank you.

(The following letter was received later:)

ADVISORY COMMITTEE ON WEATHER CONTROL,
OFFICE OF THE CHAIRMAN,
Washington, D. C., May 21, 1957.

Senator ALAN BIBLE,
Senate Interstate and Foreign Commerce Committee,
United States Senate,
Washington, D. C.

DEAR SENATOR BIBLE: On May 20 your staff requested by telephone that I comment upon Dr. Leopold's observations concerning the shortage of qualified scientific personnel set forth on pages 456–459 of the transcript of the hearings on S. 86. At those points in the hearings, Dr. Leopold stated that the position of the Department of Interior was that it would not desire to take on the responsibility for a program of research in weather modification because it would not want to compete for such scientific personnel with the other public and nonpublic agencies and universities which are meteorological in character or have meteorological organizations.

It is my personal understanding, from my previous experience in the Navy as well as in my present capacity with the Advisory Committee on Weather Control, that any agency of Government or private organization would be required to employ meteorological personnel and other scientists with special qualifications in the field of cloud physics in order to carry out the weather modification research assignment specified in S. 86. Accordingly, it would appear that whatever agency is directed by law to execute the research program contemplated by S. 86, the agency would of necessity have to reach out and acquire scientific personnel from whatever source would be available.

This observation would apply equally to the Departments of Interior, Commerce, and Agriculture as well as the National Science Foundation. Another aspect of the matter is that the numbers involved are comparatively small since the program envisaged by S. 86 would be conducted primarily by contract and the functions of the staff scientific personnel would be overall administration, supervision, and coordination of the program.

Sincerely,

HOWARD T. ORVILLE,
Chairman.

Senator BIBLE. I am wondering if we have overlooked anyone that cared to be heard on this particular bill. If not, the hearing will be concluded with the understanding that the record will be kept open for a period of 10 days until—I think that makes it May 23—for the insertion of any further statements or for any corrections in the present record.

(Additional statements with reference to S. 86:)

STATEMENT

CONCERNING S. 86, WITH APPROPRIATE BACKGROUND INFORMATION

Prepared for the Special Subcommittee on Weather Modification of the United States Senate Interstate and Foreign Commerce Committee.

The statement contains the following subdivisions: Comments on the efficacy of cloud modification with particular reference to the State of Texas; notes added in May 1957; statement concerning S. 86.

Prepared by Dr. Vance E. Moyer and Prof. Kenneth H. Jehn, professional members of the American Meteorological Society, and members of the meteorology staff, the University of Texas, Austin, Tex.

COMMENTS ON THE EFFICACY OF CLOUD MODIFICATION WITH PARTICULAR REFERENCE TO THE STATE OF TEXAS

On an overcast day in November 1946, Dr. Irving Langmuir and Mr. Vincent Schaefer, of General Electric Research Laboratories, Schenectady, N. Y., watched from different vantage points the effects of an experiment they were conducting in the free atmosphere. Dr. Langmuir waited on the ground in the hills of central New York State, while an airplane, in which Mr. Schaefer was a passenger, flew over the tops of a deck of stratocumulus clouds. From the aircraft, Schaefer dispersed finely ground particles of dry ice into the top of the cloud. The results were quickly obvious to both teams of observers. Within a short time, snow fell from the base of the cloud, while the structure of the layer was seen to change radically and unnaturally: the cloud thus "seeded" with dry ice thinned out visibly and began to dissipate as the elements of which it was composed grew to precipitable size and fell from the sky.

This event was the modern rebirth of attempts to modify natural weather events for the benefit of man. The principles upon which the experiment was conducted were not new, but their application in this fashion was the first such attempt in history.

Since that date, a controversy over the efficacy of such cloud-seeding techniques has raged unabated. There soon sprang into existence a host of commercial "rainmakers" who quickly announced glowing reports of successful results to a hopeful public. Professional meteorologists, caught unprepared to explain such effects in terms of what was then known about the physics of precipitation, were reluctant to acknowledge the claims of those who were using cloud-seeding techniques for personal gain. Numerous controlled experiments were conducted to test the efficiency of rainmaking. Although gains in precipitation seemed to result, per se, from such experiments, statistical evaluation failed to confirm this, and the controversy continued.

On February 8, 1956, the chairman of the Advisory Committee on Weather Control (ACWC) submitted to the President of the United States a report which stated that "cloud seeding produces substantial and economically important in-

creases in precipitation." The quotation stated here was intentionally taken out of context, for as such it was interpreted by the press and by those who stood to profit from such a statement. As a result, there has arisen in the minds of the uninformed the popular notion that all that one has to do to augment the precipitation that would fall naturally is to set into operation a number of strategically located ground-based nuclei generators. In fact, one commercial operator went so far as to state that "there is every reason to believe that cloud-seeding operations could materially alleviate water shortages and drought conditions wherever they appear." This is a gross misuse of the Committee's text.

Actually, the full statement of the ACWC interim report of February 1956 restricts itself to the applicability of cloud-seeding techniques in winter meteorological situations in those places where orographic uplift of surface air insures that ground dispersed nuclei reach the optimum levels within clouds, viz, the Pacific Coast States. A consultant of ACWC, Mr. H. C. S. Thom, chief climatologist and a well-known statistician, amplified on the committee's findings during a conference at Tucson, Ariz., on April 10, 1956. He commented that the "superior methodology for evaluating weather control experiments statistically" used by the committee indicated that no statistically significant results appeared to be obtained from commercial operations over level terrain; furthermore, no evaluations were offered for summertime operations.

The pertinent question that we must now consider is this: Can the practice of what is popularly called "artificial rainmaking" be put to use to alleviate the drought conditions now suffered by most of the State of Texas? The fact that the municipalities of Dallas and Fort Worth continue to hire the services of the Water Resources Development Corp. of Denver, Colo., would appear to indicate an affirmative answer, since the former city has entered into its fourth contract with that organization since November 1952 at a total cost to the city reported to be about $150,000.

PRECIPITATION PROCESSES

The development of precipitation depends largely on the motion of the air and on the physical and chemical properties of the aerosols that serve as condensation and freezing nuclei. Air motions cannot be significantly modified by man for purposes of precipitation augmentation. Nuclei may sometimes be tampered with for the benefit of man in this same sense. These factors determine the concentration, initial size distribution, and the nature of cloud particles. As soon as cloud particles have formed, the processes of condensation and coalescence begin to deform the original distribution of drop sizes because the production of potential precipitation elements is now underway. Because air motions govern the dimensions, water content, and duration of the cloud, they control not only the rates of these processes but also the period during which they operate and therefore the maximum size that the cloud particles can attain. If these particles grow large enough, precipitation will result, but again it is the air motion that determines the intensity and duration of development.

The laws governing the motion of cloud air and the formation, growth, and coalescence of cloud droplets are not firmly established. There are tremendous variations in the properties and concentrations of atmospheric aerosols, both natural and artificial, and many of these are not well known. Accordingly, it is not yet possible to postulate a general, quantitative theory of precipitation development, but we do appear to have now a reasonable qualitative picture based on simplified theoretical calculations, supported by aircraft, radar, and visual observations.

Meteorologists recognize two principal precipitation mechanisms: the Wegener-Bergeron diffusion process requiring the coexistence of ice crystals and supercooled water droplets, and the coalescence process in which water droplets collide and accrete. Radar and aircraft observations strongly suggest that the ice-crystal process is largely responsible for the release of precipitation from layer clouds which are usually sustained by upglide of only a few centimeters per second. In cumulus clouds, showers may be released through the growth by coalescence of water droplets or the growth of ice particles in the presence of supercooled droplets, and it may not be easy to draw a clear-cut distinction between the two possibilities. In cold clouds with bottom temperatures below 0°C, the growth of ice particles will be favored, while growth or droplets by coalescense will be favored in warm clouds. There will be an intermediate temperature range in which either mechanism may initiate precipitation depend-

ing upon the cloud structure and dynamics and upon the available supply of condensation and freezing nuclei.

CLOUD SEEDING

Warm clouds

The seeding of warm clouds, i. e., those in which the temperature is everywhere above 0° C, seems to be best accomplished by spraying water or other aqueous solutions from aircraft in an effort to induce rain to form by the coalescence process. This has been practiced in the United States, Puerto Rico, the Hawaiian Islands, and in Australia. There is a large measure of agreement between different experimenters and there is no doubt that given suitable conditions precipitation can be induced to fall from warm clouds by this method.

The more successful of these experiments have used large quantities of water for seeding, ranging from 500 pounds of water per cloud to more than 5,000 pounds per cloud. Accordingly, there is some question as to whether or not it would be economical to transport such large quantities of material into clouds for the purpose of causing a net change in rainfall over a wide area. The only experiments on augmentation over wide areas are those in which giant nuclei of sodium chloride have been released from the ground into air which is known to be deficient in such nuclei, but these experiments have not continued for a sufficiently long period to produce a definite answer.

Supercooled clouds

There is far less agreement on the results which have been obtained in connection with the seeding of supercooled clouds. Much effort has been expended in attempts to bring about a net change of rainfull over an area or to determine whether a net change has taken place. There are indications from controlled single cloud experiments that the use of dry ice as a seeding agent is successful for cloud temperatures colder than minus 6°C. Some unpublished data suggest that silver iodide is effective also at temperatures below minus 6°C.

Most of the experiments on supercooled clouds that have been conducted with the aim of determining the net change in precipitation have seldom been designed in a way which allows an unambiguous interpretation of the results; furthermore, these experiments have not been accompanied by positive demonstration that ground generators produce stable nuclei or that air turbulence is usually effective in spreading these nuclei throughout the target clouds. The stability of silver iodide nuclei has been questioned and little is known about the quantity required in individual cases. In addition to these uncertainties, the many unknowns in the condensation and coalescence of precipitation, the electrical factors, etc., make it impossible at present to diagnose the deficiencies responsible for lack of precipitation in individual cases and recommend specific "prescriptions" to remedy the deficiencies. In our opinion, these latter are the most serious obstacles to the use of ground-based smoke generators, especially over the level terrain that characterizes much of Texas.

It must also be clearly understood that there are certain conditions that are either favorable or unfavorable for successful cloud-seeding operations. The favorable conditions seem to be large, thick clouds from which no precipitation is falling; thermodynamic instability of the air; no temperature inversions; little vertical wind shear; high humidities; and insufficient condensation or freezing nuclei. Evidently, then, the unfavorable conditions would be the absence of clouds; the presence of a strong temperature inversion characteristic of subsiding air; large vertical wind shear; low absolute humidity; small lapse rates of temperature, i. e., stable air; week atmospheric circulation; and large quantities of cirrus clouds.

Both favorable and unfavorable conditions have been observed in Texas, of course; by and large, however, there appears to be a preponderance of unfavorable factors for the State as a whole—e. g., subsiding air and low absolute humidity—particularly during the seasons when augmentation of precipitation is most desirable. There are very good climatological reasons why portions of the State of Texas should be arid or semiarid. Any region in the "rain shadow" of the Rocky Mountains tends to be deficient in rainfall. The conditions that lead to this deficiency are precisely those that frequently, but not always, tend to nullify the chance of success of seeding operations. Before making any definite statement with regard to the results to be expected from a cloud-seeding program, therefore, it would be important to assess the proportion of favorable to unfavorable factors in the various parts of the State. In particular, it would be important to know something of the population of seedable clouds in Texas during the dry season.

There will always be regions of the earth in which it will be difficult or impossible to modify precipitation artificially. Where climatological and topographical conditions are favorable, however, such as those that occur either frequently or sporadically in some parts of our State, there are now indications that real and economically important increases in precipitation might be obtained. Only further research can reveal whether the State of Texas can exploit these conditions to optimum advantage.

CONCLUSION

The above statements on the scientific aspect of what is popularly known as artificial rainmaking, and the unenviable position of the meteorologist within the controversy that prevails between the commercial rainmakers and the statisticians who have evaluated cloud-seeding efforts, are largely paraphrases of papers delivered at the Conference on the Scientific Basis of Weather Modification Studies at Tucson, Ariz., on April 10–12, 1956, by three distinguished participants: Mr. B. J. Mason, head of the Cloud Physics Laboratory of Imperial College, London, England; Dr. E. G. Bowen, Chief of the Division of Radiophysics, Commonwealth Scientific and Industrial Research Organization, Sydney, Australia; and Dr. F. W. Reichelderfer, Chief of the United States Weather Bureau. This meeting was summarized by Dr. James E. McDonald, associate director of the host Institute of Atmospheric Physics of the University of Arizona, in the June 1956 issue of the Bulletin of the American Meteorological Society, as follows:

"The gist of this conference seemed to the writer to be essentially this. The conferring investigators did not present findings which, viewed as a whole, provide much research evidence supporting the flowing claims that certain cloud seeders have issued in past years, but they reported many recent results that document the vigorous progress that cloud physics has been making toward understanding cloud and precipitation processes. Hence, one noted a prevailing point of view that might be briefly described as cautious optimism. So little is yet known of the intricacies of precipitation processes that it seems presumptuous to assume either that we could yet expect to be exercising optimum control over cloud processes or that, alternatively, we could yet expect to have ruled out all possibility of useful control."

The same cautious optimism is reflected in the opinions of the professional meteorologists in the University of Texas. During drought years, the augmentation of precipitation by even a small amount would undoubtedly have an enormous impact on the economy of the State of Texas. However, since Texas consists mainly of level terrain, since the climate of much of Texas is such that one should expect arid or semiarid conditions to prevail normally during dry spells by virtue of its geographical location, since the efficacy of ground-based generators is questionable, and since the effectiveness of silver iodide as a nucleating agent under certain conditions is seriously doubted by many responsible researchers, normal prudence requires that our opinion stress the note of caution expressed by Dr. McDonald.

Under circumstances of economic stress, such as those that prevail at present, any means that hold promise of a possibility of relieving the drought conditions in our State probably merits the risk of a trial. It is to be hoped, however, that this trial would not be allowed to impede the chances of progress in our understanding of the processes responsible for rainfall in the Southwest; research in cloud and precipitation physics and the meteorology and climatology of Texas needs to be pressed forward even harder, so that augmentation efforts may ultimately achieve optimum returns. That they do not do so now, we stand firmly convinced.

RECOMMENDATIONS

Texas is not climatologically homogeneous. There are parts of the State in which the natural environment may tend to favor successful results in efforts to augment natural rainfall. These are, for example, the northern counties, which are most frequently influenced simultaneously by conflicting air masses that favor precipitation from layer-type clouds, and the western counties, which exhibit local irregularities in terrain over which orographic lifting of surface air might favor the use of ground generators. The greatest challenge is presented by the relatively flat lands of south, central, and parts of east Texas. Obviously, it would not be reasonable to believe that a given cloud-seeding technique would succeed equally in all parts of the State.

The scale on which an actual cloud-seeding program should be carried out for the State of Texas cannot be determined unequivocally. It is obviously a function of the available funds, the necessary time in setting up the program, and the availability of personnel, equipment, and technical ability of the experimental group. While a large-scale, statewide, cloud-seeding program could be set up, it would take a considerable amount of time, money, and organization, and, from what has been said earlier, it would probably not result in a comparable areal increase in rainfall over that which could be obtained from one or more smaller scale programs in more favorable locations. Naturally, the smaller time involved in preparation, the more simplified experimental techniques applicable, and the more rigorous evaluation possible over smaller areas would all favor the smaller scale attack. However, in the final accounting, the urgency of the need and the possible benefits obtainable must be balanced to determine the answer to this question.

Two specific recommendations must be made, however, independent of the scale on which any rain-increasing attempt is to be made. The first of these involves the fact that, from the scientific point of view, it is most desirable, first, to conduct basic research on the diffusion and coalescence mechanisms of precipitation with the aim of learning more about the processes as they operate in Texas, and then, secondly, or concurrently, to apply this knowledge in efforts to alleviate drought conditions; in no case should promiscuous cloud seeding be permitted to take precedence over the necessary research.

Recommendation 1

Accordingly, it is our recommendation that any experimental fieldwork should be strongly undergirded by rational, basic research in cloud physics. We recognize the urgency caused by the present drought situation, but the unbiased evaluation of experimental work is so important that carefully conducted, experimental seeding is the only kind which should ever be done by any group, especially considering the present state of knowledge on the subject. A recommendation of the President's Advisory Committee on Weather Control is pertinent here; it states in part:

"* * * the Committee finds that, in view of the importance of the weather and weather conditions to the economics and the well-being of the Nation, the number of scientists engaged in research on basic phenomena of the atmosphere is far too small; that the present state of our knowledge is far from adequate from the standpoint of effective application to modification of weather and climate; that determined and continuing effort must be made to train more students to become competent research workers in the sciences that pertain to the weather. * * *"

Recommendation 2

Secondly, it is our feeling that the university itself should not assume the role of cloud seeder, as such, for any State of Texas cloud modification program, but should rather administer, coordinate, and evaluate the experimental program. A State organization such as the Texas Water Water Resources Committee, the Division of Defense and Disaster Relief, the various river authorities, county agents, the Civil Air Patrol, the Texas Air National Guard, etc., or perhaps commercial seeders should make the necessary arrangements for equipment and field personnel for the program. Administration and control of the project, however, would be an essential prerequisite to university participation, since there is a danger that the University of Texas might otherwise become umpire rather than evaluator, and this we do not wish. It is also important that any cloud modification effort in the State of Texas be coordinated with the President's Advisory Committee on Weather Control, as a rational means of sharing weather modification experience for the benefit of all. Much of our present knowledge on this subject is due to the work of this group over the last 2 years, particularly the evaluation aspect of weather modification.

One approach to the problem facing the State of Texas, and therefore the university, would be to seek local or State support for at least a part of a research program—the experimental, or applied—and to invite support from some such organization as the National Science Foundation for the essential basic research. Since 1954, the Institute of Atmospheric Physics of the University of Arizona has been studying the meteorology and climatology of the Southwest with particular emphasis on Arizona. A total annual budget of about $100,000 has been provided by the Alfred P. Sloan Foundation, the National Science Foundation, and the State of Arizona, with the latter contributing about half.

While the underlying motivation for the establishment of this institute in Arizona was that of water resources, no direct cloud-seeding experiments have yet been pursued, but rather basic research on rain-producing mechanisms is being accomplished. This has involved the use of aircraft and radar in sampling clouds and air. A detailed cloud census is being made with the aim of determining the number of precipitating and nonprecipitating clouds that affect each region of Arizona and the characteristics that differentiate the two types. The institute is also preparing detailed climatological surveys of various areas in order to relate seasonal variations of the general state of the atmosphere to cloudiness and precipitation. This work by Arizona's Institute of Atmospheric Physics will be of value to the State in such widely diverse fields as tourism, water storage, and flood control, in addition to forming the scientific basis for forecasting rain-producing and incipient rain-producing situations.

Recommendation 3

It is proposed that a similar program would be of significant value to the State of Texas. The various climatic regimes in Texas cover a wide variety ranging from desert to near tropical, and while some of the results of the Arizona pioneering studies can be utilized in Texas, the problems are in general not the same. The most effective attack on the atmospheric aspects of Texas water resources can only be made through an organization devoted to what might be termed the physical climatology of weather modification.

The present document represents the carefully considered thoughts of the professional meteorologists currently in the employ of the University of Texas. In summary, this group believes that a rainfall augmentation program holds promise of benefit to the State of Texas. The individuals of this group are well qualified to participate in such a program and are willing to do so. However, this participation would be of a supervisory or coordinative nature and should include specification of a broad-scale research effort that would promote optimum benefits to the people of the State of Texas.

VEM: August 1956.

NOTES ADDED IN MAY 1957

The foregoing report on the efficacy of cloud modification was originally prepared in response to a request from Dr. Logan Wilson, president of the University of Texas, for a rational explanation of what cloud seeding is and what it can be expected to do. In the summer of 1956, there was considerable public pressure on various State of Texas agencies to "do something" about the drought. The University of Texas board of regents, following the submission of our report and the further submission of a proposal for a modest program of research into the physical climatology of Texas, authorized in September 1956 a pilot program in what might be called the physical climatology of weather modification, the first in the State of Texas.

In less than 1 year, a rational program has been worked out by Dr. Moyer, director of the regent's study of weather modification, and several aspects of Texas climate have been delineated. Recently, the board of regents authorized a continuation of this work for another year. In delineating the various climatic regions of Texas on a rational basis, and in determining the variability of temperature and precipitation "normals," Dr. Moyer and his coworkers have begun to lay the groundwork for a rational experimental program in weather modification in Texas.

There have been some changes since August 1956, of course. Texas drought has become Texas flood in recent months. Dr. Moyer, in his report to the university board of regents, had this to say:

"The early months of 1957 have witnessed a hopeful transition in the weather over much of the State of Texas: There are signs that the terrible drought, which began in 1949 and continued through 1956, is beginning to abate. An air of optimism pervades the miens of businessmen and farmers, ranchers and laymen. Texas is colored with a shade of green that has not been seen for many years. Everywhere one hears, 'The drought is ending; we are returning to normal times.'

"This optimism is shared by the professional meteorologists who have concerned themselves with this exposition of the vagaries of their milieu. Like any other ordinary men, they, too, profit from the additional rain that falls without cost on their lawns and gardens. But they are seriously disturbed with the effects that this apparent reversal in weather cycles is bound to have on public awareness.

"Drought will return to Texas. There is every reason to believe that within the next 15 to 20 years, our State will once more suffer the pangs of public and private thirst. As more and more data are added to man's short span of recorded observations, the validity of the hypothesis of sun-spot activity as the cause of short-term trends in climatic variation, which was advanced by Dr. Hurd C. Willett, eminent professor of meteorology in the Massachusetts Institute of Technology, on the basis of an 80-year study, appears closer and closer to confirmation. Witness the facts, established by Willett, that parts of the Southwest have experienced serious droughts in about the years 1875, 1895, 1915, 1935, and 1955. Simple extrapolation demands that we predict a recurrence of damaging aridity in 1975, give or take a few years.

"With this presumption as a basis of our thinking and planning, it is vitally important that the people of the State of Texas take steps to prepare for this near-future event. Our State is undergoing an unprecedented expansion in industrialization and growth in population. This development must drain heavily on the one crucial natural resource of the State: Water. Even if "normal" precipitation should soon return, increased demand on the water resources will cause a shortening of the available supply. Every conceivable expedient for increasing this supply must be prosecuted with intelligence and foresight, for otherwise we may prematurely suffer a manmade drought.

"There are several such expedients that are worthy of our attention. Chief among these are conservation and reclamation. Since these are most readily understood by the general public, they have received nearly as much attention as they warrant, as witness the activity of the 55th legislature. However, there are other expedients, much more poorly understood by the man on the street, that may prove economically important if permitted to develop rationally. Among these are the reclamation of sea water, the transportation of surplus water from geographical areas outside Texas, the impoundment of wasted runoff, the reduction of evaporation from reservoirs, and the augmentation of natural precipitation by so-called artificial means. It is with the latter that we are here concerned."

STATEMENT CONCERNING S. 86

In the light of the foregoing background information, it is the considered judgment of the professional meteorologists (J. R. Gerhardt, K. H. Jehn, V. E. Moyer, R. C. Staley, and N. K. Wagner) currently in the employ of the University of Texas that S. 86, a bill introduced by Senator Case into the Senate of the United States on January 7, 1957, represents a forward step in a much-needed program in support of fundamental meteorological research, with especial reference to cloud modification and its supporting fields of cloud physics and physical climatology. It is noted that there are two means available to the Advisory Committee on Weather Control for support of research: One by direct contract with qualified private or public agencies, and the other by cooperative programs with State agencies involving matching funds.

There are several points which we would like to make concerning the projected program represented by this bill.

First, in view of the urgent need for undergirding any fieldwork in cloud modification with basic research in cloud physics and physical climatology, it is hoped that adequate provision for such basic research is provided for other sources (National Science Foundation, for example). With the emphasis on an experimental program, there is the danger that important basic research will be slighted.

Second, fieldwork in cloud modification is expensive when done properly (that is, from both ground and air). The potential sum of $8,750,000 to be spent over a 5-year period (if matching funds are provided to the extent of 75 percent of the $5 million noted in S. 86) is a relatively small amount, considering both the cost of experimental work on an atmospheric scale and the many areas in the United States in which systematic fieldwork should be undertaken. Therefore, some consideration should be given to increasing the total funds available over the 5-year period.

Third, it is our recommendation that the available funds (of whatever amount) be spent on intensive cloud modification research in a few areas to be selected by the Advisory Committee on Weather Control, rather than spreading the research funds thinly over numerous local areas. It seems to us that a potentially greater return on the investment of the research dollar is favored by intensive work on a few areas.

Finally, a period of 5 years is an absolute minimum from the point of view of statistical verification of the efficacy of cloud modification. Serious consideration should be given to extending the period of support to qualified research groups to a period on the order of 8 to 10 years.

STATEMENT OF JOSIAH FERRIS, VICE PRESIDENT, THE AMERICAN SUGAR CANE LEAGUE OF THE U. S. A., INC.

Mr. FERRIS. My address is 510 Union Trust Building, Washington, D. C. I am a vice president and manager of the Washington office of the American Sugar Cane League of the U. S. A., Inc.

The American Sugar Cane League is a nonprofit corporation domiciled in the State of Louisiana. Its membership consists of more than 7,000 Louisiana sugarcane farmers, who produce approximately 98 percent of the sugarcane grown in the State of Louisiana, and of all of the Louisiana processors of sugarcane into sugar. I appear at this hearing on behalf of that organization and its members.

Sugarcane is the only cash crop on the vast majority of these 7,000 Louisiana farms, and there is no satisfactory cash farm enterprise that can be substituted for sugarcane.

The Louisiana producers of sugarcane and processors of sugarcane into sugar are definitely interested in the ultimate enactment of Senate bill No. 86 which relates to weather modifications. Rainfall and moisture is a limiting factor in sugarcane yields in the State of Louisiana practically every year. While it is true the average annual rainfall in the Louisiana sugarcane area is approximately 60 inches, our rains do not usually come throughout the growing season, and each year, with few exceptions, the growth of the cane is adversely affected by one or more periods with little or no rainfall.

The normal cane-growing season in Louisiana is the period from April through October, and the peak growing period is from June through September. During much of the peak growing period, if there is adequate moisture the sugarcane will grow approximately 1 inch each day. In the absence of moisture or adequate moisture, this growth is seriously retarded. Therefore, it is obvious the demand for moisture in the Louisiana sugarcane area during the peak growing period is constant and substantial.

In considering Senate bill 86 in relationship to sugar, it should be borne in mind that sugar, which is produced from sugarcane and sugar beets, is not a surplus crop in the United States. Only 30 percent of the Nation's requirements are produced on the mainland of the United States and only 55 percent of the Nation's requirements are produced in all domestic areas including Hawaii, Puerto Rico, and the Virgin Islands. Approximately 45 percent of our sugar requirements are met by sugar imported from foreign countries.

In view of the facts which I have briefly and generally stated, the American Sugar Cane League and the Louisiana sugarcane farmers and processors are naturally and vitally interested in any properly directed research that might eventually lead to a practical method of obtaining additional rainfall when needed. We, therefore, endorse Senate bill 86 and urge a favorable report of this committee.

Senator BIBLE. I would like to insert in the record at this point some miscellaneous letters and telegrams regarding S. 86.

ALBERT, N. MEX., *May 3, 1957.*

Hon. ALAN BIBLE,
Senate Office Building, Washington, D. C.

MY DEAR SENATOR: It has just come to my attention that there rests in your committee for hearings in the next few days Senate bill 86 that provides funds for research and for the continuing of the Advisory Committee that has been established in the Department of Commerce in connection with the whole matter of the weather-control program.

This question is of such tremendous interest to such a large area of our country that I urge the program set up in the original bill be carried through if possible. I understand the House has taken adverse action to one or two of the provisions. I feel it is essential to have the Advisory Committee continued in this general program. The funds proposed are definitely needed in order to come up with the facts we should know in connection with artificial weather control. I also feel that those who have pioneered this valuable service have facts and information that will be helpful in developing the knowledge that we should have in order to know how to proceed with this program.

In closing, I commend you for your interest and leadership in this project.

With best wishes.

Sincerely yours,

ALBERT K. MITCHELL.

DENVER, COLO., *April 19, 1957.*

Re bill S. 86.

Senator ALAN BIBLE,
Senator from Nevada,
Senate Building, Washington, D. C.

DEAR SENATOR BIBLE: This letter is prompted by the fact that we are ranch owners, and have been for nearly the past 100 years. Our holdings are located in Texas and Colorado, with the Texas property falling in the drought, and so-called, disaster area.

In the operation of the above properties we have been most active, for the past 10 years, in the field of cloud modification research, together with its practical application. The financial burden for a carefully evaluated program has been considerable for us, but has shown great promise. We believe this work to be responsible for our present operational capacity, while our general area has been sorely stricken.

I am somewhat alarmed by the scope of bill S. 86 because the appropriation is far too small to accomplish the stated aims of the bill. The areas in need are so tremendous and the evaluation, from a technical point of view, is difficult and time consuming. Why, therefore, is it not far more practical to assist those projects which have desperately pioneered this work and have a backlog of experience. Supplement and evaluate the work done so far and hold the power of discretion in the committee itself; as the cost of familiarization and creation of small field research projects will most certainly absorb the momentum thus far gained. I cannot emphasize too strongly that the heart and soul of this work lies not so much in the field application, but the fundamental calculations necessary to obtain the required forecasts for this type of program. Small research groups scattered about the Nation could only succeed in educating themselves to this point of realization.

Our work has been conducted by the Water Resources Development Corp., of Denver, and it is our strong conviction that such a private contractor can deliver a better dollar value, as the results delivered are a direct measure of their worth and integrity. The loss in duplication of work could be staggering and the committee should exercise the greatest care not to lose or set back the progress that we ourselves feel, we have already contributed.

It is, therefore, our sincere plea that S. 86 be appropriately amended.

Very truly yours,

CHARLES J. HUGHES, *Cotrustee.*

APRIL 24, 1957.

Hon. ALAN BIBLE,
United States Senate, Washington, D. C.

DEAR MR. BIBLE: Just a moment of your time, if I may, to discuss Senate bill 86.

For the past 8 years, there has been a weather modification program conducted in southern Oregon by the Rogue River Valley Pear Shippers' Association.

This work has been done both by aerial application and ground generator methods. We have operated our own aircraft and have used the services of Weather Modification, Inc., whose headquarters are in Denver, Colo.

All in all, private industry in this area has spent $224,216.96 in the interests of various types of weather modification. The California Oregon Power Co., also of this region, has had their own weather modification program in operation for many years and have, I am sure, spent a sum approximating that which we have spent. Undoubtedly, there are many other areas of the United States in which private capital has been used for research work, in addition to the research which has been carried on by the Armed Forces.

While it is a difficult area for agreement, it is definitely my impression that the science is still a very exact one about which not too much is known. And since it has been the practice of private enterprises to do this particular job themselves, I frankly feel the money necessary to operate in accordance with S. 86 would be an unnecessary burden to place upon the taxpayers of this country at this time. It would be a case of the Government stepping in to do a job for people who, by demonstration, are willing to do the job themselves.

Accordingly, I urge you not to lend your support to S. 86.

Sincerely,

HARRY & DAVID
DAVID H. HOLMES, *President.*

MEDFORD PEAR SHIPPERS ASSOCIATION,
Medford, Oreg., April 19, 1957.

Hon. ALAN BIBLE,
United States Senate,
Senate Office Building, Washington, D. C.

DEAR MR. SENATOR: The Medford Pear Shippers Association is made up of the firms engaged in packing, storing, and marketing fresh pears from the Rogue River Valley in southwestern Oregon. The production is from about 10,000 acres of orchards. This area is entirely surrounded by mountains and is subject to considerable thunderstorm activity. In past years intensive hail damage has been experienced during the growing season.

As a result, we started a research program of cloud seeding in 1949 for the prevention of hail. This project has been in operation each summer since that time. We are now starting our ninth year, which makes this one of the oldest industry-controlled and financed weather modification projects in the world. In our ninth year of operation, after expending some $300,000, we are still trying to arrive at a correct evaluation.

All the above is mentioned as an illustration of the cost and time involved in a weather modification project such as is contemplated in S. 86, introduced by Senators Case of South Dakota, Anderson of New Mexico, Magnuson of Washington, and Watkins of Utah.

This bill would limit Federal expenditures of the Advisory Committee on Weather Control to $5 million over a 5-year period.

The Medford Pear Shippers Association wishes to make a vigorous protest against the passage of this bill for the following reasons:

1. The amount of financing is so ridiculously small for the area involved that no adequate program can be carried out.

2. The period of 5 years is far too short a time to evaluate such widespread experimentation.

3. We feel that this program, if carried out, should be financed by the industries or States involved; that this is no time to increase Government expenditures for services affecting such a small segmention of the Nation.

For the reasons outlined, we respectfully request that you use your influence to defeat this measure.

MEDFORD PEAR SHIPPERS ASSOCIATION,
S. M. TUTTLE,
Chairman, Weather Control Committee.

City of Dallas, Tex.,
Department of Water Works,
April 22, 1957.

Senator Alan Bible,
Senate Office Building,
Washington, D. C.

Dear Senator: I have followed with interest the proposed Federal legislation allocating some $5 million for research and field projects in weather modification. You have perhaps heard that the city of Dallas pioneered in the commercial application of weather modification as far back as 1952, when much less was known about it than now. We renewed our contract at appropriate times through the drought period, despite the fact that there was no reliable rule of measuring the effectiveness of the program, simply because our water supply situation was critical enough to warrant a calculated risk. We are confident that, under certain conditions not readily determinable, cloud seeding will increase rainfall. This conclusion on our part has been confirmed by many scientists in the field of meteorology on an observed basis, although they could not prove their belief with reliable, statistical accuracy. This, of course, is especially true in the Southwest flatland countries where significant rains may not exceed 10 to 15 a year.

Although we have not found it advisable to continue weather modification work in Dallas, I certainly do believe in its potential. Our period of water shortage pointed out just how important it could be to our entire country if basic research could provide a reliable basis for its application. I believe this is the type of project to which Federal funds are most ideally suited because of its national significance. Even those engaged in the commercial application of weather modification agree that the science could profit greatly by basic research in meteorology.

Closely interrelated with weather modification, and highly important in determining when and where it may be applicable, is the field of long-range forecasting. In operation of impounding reservoirs in the Southwest we are deeply concerned with what we call safe yield. This is the safe amount which can be withdrawn from an impounding reservoir during a drought of record where evaporation will be at its maximum.

During such periods you use the historical minimum runoff into the reservoir and evaporation as the major offset to withdrawals. One year of drought may or may not denote the onset of a drought of record, and for this reason you dare not withdraw from a reservoir annually more than its safe yield even though the odds are it will spill the next year. However, with reliable long-range forecasting you can see the immediate significance of being able to release more than the safe yield to relieve a drought situation for the period of reliable forecasting. I am sure the farmer, too, would have an even greater economic interest in reliable, long-range, weather forecasting.

I note with interest that the Weather Bureau has recently stepped from its role of ultraconservatism and has at least given the public the benefit of its best estimates in this field of long-range weather forecasting although they stress the unreliability of such forecasting. The Weather Bureau, at least in our section, also seems somewhat negative in regard to the practicability of weather modification. I make this statement without recommending pro or con as to who should administer any research program in this field which you might approve. I fear that any recommendation on my part would be presumptuous in the light of your experience and knowledge of the various Federal and private agencies qualified to carry out the work.

Please accept these comments and statements as an effort to assist you in your deliberations and, in the event our experience can be of any help, please do not hesitate to ask it of us.

Sincerely,

Henry J. Graeser,
Superintendent, Dallas City Water Works.

Cochran-Odlum Ranch,
Indio, Calif., March 25, 1957.

Hon. Alan Bible,
United States Senate, Washington, D. C.

Dear Senator Bible: Neither I nor any members of our Atlas Corp. organization plans to appear at the hearings on cloud or weather modification.

I am generally familiar with the effects of and problems connected with weather modification. Its potentials are great. It should be followed up. Weather modification, atomic energy, and the purification for use of sea water are three things that will give us a great future. They hold much for us here in the West, where the greater part of our increased population will take root. Equally, they will bring prosperity to many undeveloped areas of the world.

I personally think a couple of million dollars a year spent on weather modification in the upper Colorado Basin will bring more water for use in and from the lower basin than all the dams and reservoirs which will cost several hundred million dollars.

Sincerely,

FLOYD B. ODLUM.

DIXIE, LA., *April 19, 1957.*

Senator ALAN BIBLE,
Washington, D. C.

DEAR SENATOR BIBLE: The Red River Valley Water Resources Association is an organization of farmers in six parishes in northwest Louisiana. We are organized to promote and supervise cloud-seeding operators to assist in increasing rainfall when needed.

We have been engaged in this project since 1955 and feel that it is a very successful program, but each year find it increasingly difficult to raise funds to continue.

We are definitely interested in Senate bill 86, which is being proposed for weather modification and cloud-seeding research.

It is our understanding that you are chairman of the committee that will hold hearings on this bill. We urge you to do all you can to represent us at this hearing, since all the directors of our association are actively engaged in crop planting at this time and will be unable to attend.

However, we do recommend that control of this program be given the Weather Advisory Committee and that actual cloud-seeding operations in each State be done by districts or associations such as ours.

The reason for this request is that we believe a statewide cloud-seeding program would be detrimental to some farmers, and feel that a State advisory committee composed of chairmen of the various State districts could work in harmony and perform a worthwhile job.

Hoping this letter will serve in our absence, I remain,

Very truly yours,

FLOYD E. VOLENTINE,
President, Red River Water Resources Association.

LOOMIS, CALIF., *April 22, 1957.*

Hon. CLAIR ENGLE,
Second District of California,
House Office Building, Washington, D. C.

HONORABLE SIR: The contents of S. 86 and your companion bill have been brought to our attention. If we understand the intent, it would mean a $5 million appropriation for weather-modification study, 75 percent of which would be allocated on a State matching-fund basis.

As you know, we have been working a hail-suppression program for the past 7 years, and other groups have been operating similar programs. To date, the cost of this experimentation has been borne by private enterprise and, in our particular case, by the farmer himself. It therefore appears to us that Federal assistance to groups already engaged in weather modification would be more desirable. Valuable information gained during the past several years would be readily available, farm groups such as ourselves would be partially compensated for the pioneering work, and the taxpayer would be getting value received.

May we urge you to give your considered opinion to our suggestion, and, if it seems a more desirable approach, will you confer with the other sponsors of this legislation?

Yours very truly,

PLACER COUNTY FARM LABOR CO-OPERATIVE, INC.,
HARVEY CARISLE, Jr., *President.*

CORNING, IOWA, *May 10, 1957.*

Senator ALAN BIBLE,
Senate Chamber, Washington, D. C.:

Would appreciate your support of S. 86. Is a much needed bill.

ADAMS COUNTY WEATHER MODIFICATION ASSOCIATION,
F. A. TURNER, *Chairman.*

LOVELOCK, NEV., *March 23, 1957.*

Hon. ALAN BIBLE,
United States Senate, Washington, D. C.:

Pershing County Chamber of Commerce urges your support of Senate bill 86, the Cloud Modification Research Act of 1957. On passage of this measure please exert your good offices to secure a pilot plant in the Humboldt River basin area.

T. F. JOFFEE,
Secretary Pershing County Chamber of Commerce.

ALBION, NEBR., *April 25, 1957.*

Senator ALAN BIBLE of Nevada,
Chairman, Special Committee on Bill 86, Washington, D. C.:

Since 1955 our nonprofit corporation has had a voluntarily financed cloud-seeding program for 1,200,000 Nebraska acres. We firmly believe potential results. Want continued investigation and experiment and experimentation by President's Advisory Committee on Weather Control.

Cornhusker Weather Modification Association; Jim Wolf, President, Albion; Lloyd Levos, Vice President, Petersburg; E. Roger Blatter, Herman Estrem, Jack Lough, Glenn Wright Albin, Harry V. Fowler, Council Bluffs; Frank C. Braun, Humphrey; Orville Limbo, Oakdale, E. L. Burke, Jr., Genoa.

RED OAK, IOWA, *May 13, 1957.*

Senator ALAN BIBLE,
Senate Chamber, Washington, D. C.:

We urge your committee to support bill S. 86.

MONTGOMERY COUNTY WEATHER MODIFICATION ASSOCIATION,
EARL MCQUOWN, Jr., *Chairman.*

SHENANDOAH, IOWA, *May 13, 1957.*

ALAN BIBLE,
Senate Chamber, Washington, D. C.

Page County Weather Modification Association supports S. 86, Case bill.

GEORGE YAPLE, *President.*

ALCESTER, S. DAK., *April 18, 1957.*

ALAN BIBLE,
United States Senator,
Senate Office Building, Washington, D. C.

The Sioux Valley Weather Association, Inc., comprising 7 southeastern South Dakota counties strongly urge that the administration of the proposed S. 86 be vested in the Advisory Committee. This, in our opinion is more vital even than the amount of the appropriation. This research committee has laid the groundwork through years of research to activate at once the weather modification program. Another Government agency would undoubtedly insist on starting from scratch to build up their own research files which would delay and bog down our weather modification program for years.

E. F. MCKELLIPH, *President.*

COLORADO SPRINGS, COLO., *April 17, 1957.*

Senator ALAN BIBLE,
Senate Office Building, Washington, D. C.

Re Senate bill 86, sincerely believe Advisory Committee on Weather Control best qualified to administer appropriation exclusively. Further believe supporters of private weather modification projects and areas which have heretofore pioneered such projects should receive specific allocations prior to other areas.

T. M. DINES.

Senator BIBLE. With that, then, we will stand adjourned.

(Whereupon, at 5:39 p. m., hearing in the above-entitled matter was adjourned.)

×

LEGISLATIVE HISTORY

Public Law 85-510
S. 86

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INDEX AND SUMMARY OF S. 86

Jan. 7, 1957	Senator Case introduced S. 86 which was referred to Senate Committee on Interstate and Foreign Commerce. Print of bill as introduced.
July 11, 1957	Senate committee reported S. 86 with amendments. Print of bill and Senate report No. 607.
Aug. 5, 1957	Senate passed S. 86 as reported.
Aug. 6, 1957	S. 86 was referred to House Committee on Interstate and Foreign Commerce. Print of bill as referred.
Mar. 27, 1958	House Committee ordered S. 86 reported with amendment.
May 7, 1958	House committee reported S. 86 with amendments. Print of bill and House report No. 1695.
June 12, 1958	House Rules Committee reported House Resolution 590 (House report No. 1876) for consideration of S. 86. Printed copies of resolution and report not received.
June 19, 1958	House passed S. 86 as reported. (With amendments).
July 1, 1958	Senate concurred in House amendments.
July 11, 1958	Approved: Public Law 85-510.

Senate committee held hearings March 26 and May 13, 1957.
House committee held hearings March 18 and 19, 1958.

DIGEST OF PUBLIC LAW 85-510

WEATHER MODIFICATION RESEARCH. Amends the National Science Act of 1950 so as to authorize the National Science Foundation to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena, and to report annually to the President and the Congress thereon. Provides that the Foundation shall consult with meteorologists and scientists in private life and with agencies of Government interested in, or affected by, experimental research in the field of weather control. Authorizes the conduct of research through contracts with, or grants to, private or public institutions or agencies, including but not limited to cooperative programs with the States. Authorizes the Foundation to accept gifts, money, material, or services for conducting research projects. Authorizes Government agencies to loan the Foundation without reimbursement property and personnel, with the approval of the Director of the Bureau of the Budget. Authorizes the Foundation to require by subpena information necessary to carry out the provisions of this Act.

85TH CONGRESS
1ST SESSION

S. 86

IN THE SENATE OF THE UNITED STATES

JANUARY 7 (legislative day, JANUARY 3), 1957

Mr. CASE of South Dakota (for himself, Mr. ANDERSON, Mr. MAGNUSON, and Mr. WATKINS) introduced the following bill; which was read twice and referred to the Committee on Interstate and Foreign Commerce

A BILL

To provide for an experimental research program in cloud modification.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*
3 That, for a period of five years following the effective date
4 of this Act, the Advisory Committee on Weather Control
5 be authorized and directed to formulate a program of experi-
6 mental research in the field of cloud modification with special
7 reference to areas in the States that have suffered from
8 shortage of natural rainfall.

9 SEC. 2. The experimental research program authorized
10 by this Act shall be carried on either by contracts between
11 the Advisory Committee on Weather Control and private or

1 public agencies and through cooperative programs with State
2 agencies, including land-grant colleges or other State agencies
3 to be designated by the governor of the State.

4 SEC. 3. There is hereby authorized to be appropriated
5 a sum not exceeding $5,000,000 for the accomplishment of
6 the program herein authorized: *Provided,* That of the amount
7 appropriated annually during the five years for which this
8 program is authorized, one-fourth shall be available for that
9 part of the program to be accomplished by contract and three-
10 fourths shall be available for the cooperative program to be
11 matched equally by the States.

12 SEC. 4. This Act may be cited as the "Cloud Modifica-
13 tion Research Act of 1957".

85TH CONGRESS
1ST SESSION

S. 86

A BILL

To provide for an experimental research program in cloud modification.

By Mr. CASE of South Dakota, Mr. ANDERSON, Mr. MAGNUSON, and Mr. WATKINS

JANUARY 7 (legislative day, JANUARY 3), 1957

Read twice and referred to the Committee on Interstate and Foreign Commerce

Digest of CONGRESSIONAL PROCEEDINGS
OF INTEREST TO THE DEPARTMENT OF AGRICULTURE

OFFICE OF BUDGET AND FINANCE
(For Department Staff Only)

Issued July 12, 1957
For actions of July 11, 1957
85th-1st, No. 121

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HIGHLIGHTS: Sen. Williams and others commended Secretary for curtailing loans for poultry expansion. House Rules Committee cleared mutual security authorization bill.

SENATE - July 11, 1957

1. POULTRY; FARM LOANS. Sens. Williams, Bush, Butler, Cotton, and Allott commended the Secretary for his action in seeking to restrain credit that would result in expansion of the poultry industry. pp. 10182-3

2. MINING. The Interior and Insular Affairs Committee reported with amendments S. 2039, to clarify the definition of labor required to be performed to hold unpatented mining claims on Federal lands (S. Rept. 608). p. 10175

3. WEATHER CONTROL. The Interstate and Foreign Commerce Committee reported with amendments S. 86, to provide for a research program in cloud modification (S. Rept. 607). p. 10175

4. APPROPRIATIONS. Sen. Johnson urged larger appropriations for public works and water development projects, comparing the total cost of water resource development in U.S. history ($17 billion) with the expenditure of $60 billion for foreign aid since World War II ended. pp. 10186-7

5. PROPERTY; RECORDS. The Reorganization subcommittee of the Government Operations Committee ordered reported to the full committee the following bills: (p. D640)
Without amendment, S. 2231, to permit the exercise of options in certain leases of Government property;

Without amendment, S. 2283, to authorize an administrative operations fund in GSA;

Without amendment, S. 2177, to authorize the destruction of Government records overseas in certain cases; and

With amendment, S. 2224, to require advertisements for bids before disposing of surplus property, with certain exceptions.

6. BUDGET. Sen. Johnson inserted a table showing reductions of $4 billion in the budget, with "ample room for further reductions," and asserted that the Mutual Security appropriation, even lower than the authorization, would reduce the budget substantially further. p. 10175

7. AREA DEVELOPMENT. Sen. Kennedy urged passage of S. 964, the area development bill, to aid communities not sharing in the national prosperity. p. 10186

8. FISCAL POLICY. Sen. Humphrey inserted an article, "Where Tight Money Is Really Taking Hold," on the effects of the credit squeeze on business. pp. 10191-2

9. ELECTRIFICATION. Sens. Javits, Johnson, Knowland, Lausche, Morse, and Clark discussed the disposition of S. 2406, to authorize development of Niagara River power, and Sen. Javits inserted two editorials urging immediate consideration of the bill (pp. 10179-80, 10184-6). This bill remained the pending business of the Senate (p. 10194).

Sen. Neuberger urged the President to see the advocates of Hells Canyon dam as he did those opposing the civil rights bill. p. 10180

HOUSE

10. FARM LOANS. Agreed to a resolution for consideration of H.R. 3753, to permit the Farmers' Home Administration to make loans under the Bankhead-Jones Farm Tenant Act and the Water Facilities Act to desert-land entrymen on the same terms as such loans are now made to homestead entrymen or those who have contracted for the purchase of farmlands in a reclamation project. pp. 10249-51

11. FOREIGN AID. The Rules Committee reported a resolution for consideration of S. 2130, the mutual security authorization bill for 1958. p. 10308

12. PROPERTY. The Veterans' Affairs Committee reported without amendment H.R. 2237, to authorize the transfer of certain property of the VA to the Johnson City, Tenn., National Farm Loan Assoc. and the East Tennessee Production Credit Assoc., local units of the Farm Credit Administration (H. Rept. 791). p. 10308

13. BUILDINGS. A subcommittee of the Public Works Committee ordered reported with amendment H.R. 4660, to repeal the Public Buildings Purchase Contract Act of 1954, and to require certain distribution and approval of new public building projects. p. D642

14. FOOD ADDITIVES. Rep. Osmers spoke in favor of the passage of legislation for more adequate testing of chemical additives in foods, stating that "inadequately tested chemical food additives is greater than the dangers from atomic fallout." pp. 10292-93

Digest of CONGRESSIONAL PROCEEDINGS

OF INTEREST TO THE DEPARTMENT OF AGRICULTURE

OFFICE OF BUDGET AND FINANCE
(For Department Staff Only)

Issued July 17, 1957
For actions of July 16, 1957
85th-1st, No. 125

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HIGHLIGHTS: House debated mutual security authorization bill. House committee reported bill to permit use of soil bank acreage in establishing future acreage allotments. Senate received USDA feed grains report. Sen. Fulbright announced postponement of hearings on bill to increase interest rates on certain Government loans.

HOUSE

1. FOREIGN AID. Continued debate on S. 2130, the mutual security authorization bill. pp. 10713-66

2. ACREAGE ALLOTMENTS. The Agriculture Committee reported without amendment H.R. 8030, to amend the Agricultural Adjustment Act of 1938 so as to provide that acreage placed in the soil bank shall be counted as a part of total acreage for purposes of establishing future acreage allotments for a farm (H. Rept. 817). p. 10771

3. FORESTRY. Conferees were appointed on S. 469, to authorize the U.S. to defray the cost of assisting the Klamath Indians to prepare for termination of Federal supervision, and to defer sales of tribal property, including timberlands. (p. 10703) Senate conferees were appointed June 24.

4. ADMINISTRATIVE ORDERS. The Judiciary Committee ordered reported with amendment H.R. 6788, to authorize the abbreviation of the record on the review or enforcement of orders of administrative agencies by the courts of appeals and the review or enforcement of such orders on the original papers and to make uniform the law relating to the record on review or enforcement of such orders. p. D658

Senate - July 11, 1957

5. GRANTS-IN-AID. Rep. Pelly urged the passage of legislation authorizing a study of Federal grants-in-aid. pp. 10766-67

SENATE

6. FEED GRAINS. Received from this Department a report on the study of possible methods of improving the feed grain program. p. 10642

7. LOANS. Sen. Fulbright announced the postponement of the Banking and Currency Committee hearings on S. 2427, to improve the coordination between the loan programs and fiscal and credit policies of the Federal Government, until the next session of Congress, and inserted correspondence with the Budget Bureau on the effects of the bill, including an increase from 2% to 3 5/8% for REA loans from the Treasury and from 3% to 3 3/4% for FHA loans, and an increase to the same rates as the minimum for new borrowers. pp. 10652-3

8. TOBACCO. Sen. Cooper urged the Senate to wait for more studies on whether cancer was caused by cigarette smoking before enacting bills to require warning labels on cigarette packages, and inserted statements by a scientist and men in the tobacco industry commenting on the Surgeon General's statement. pp. 10658-61

9. DISASTER RELIEF. Sen. Yarborough inserted a report from the Small Business Administration relative to the disasters in Texas this spring. pp. 10664-5

10. INTEREST RATES. Sen. Bush inserted tables showing interest rates abroad and a statement on the monetary restraints imposed by European nations in order to check inflation. pp. 10640-1

11. WEATHER-CONTROL RESEARCH. In reporting S. 86 (See Digest 121) to provide for research in cloud modification, the Committee amended the bill so as to (1) give the National Science Foundation overall authority over the program through grants to, or contracts with, public or private institutions or agencies and (2) enlarge the scope of the program so as to include the phases of weather modification such as suppression or diminishing of hail, lightning, fog, smog, tornadoes, and other weather phenonema.

12. PUBLIC WORKS APPROPRIATION BILL, 1958. The Senate report on this bill, H.R. 8090, dated July 12, includes statements as follows:

Water resource development. "The program of water resource development has not had a green light for almost two decades. In fact, except for the navigation phase of this program, its entire existence has been marked with one emergency after another...

"During the previous 2 years this committee recommended a number of new starts on urgently needed and long-deferred projects. The day is here when this country needs an accelerated program of soil and water conservation due to a succession of emergencies. The program for conservation of our natural resources has lagged far behind the general economic development of this Nation. The committee has therefore recommended a few new starts on projects in each of the major fields of resource development covered in this bill. The relationship of these programs to our economy are discussed in the following paragraphs."

Water Supply. "The River and Harbor bill, S. 497, as passed by the Senate includes provision for a more realistic approach to the repayment by local interests for the cost of water supply features of multi-purpose reservoirs. For a number of years this committee has discussed in its reports the

Calendar No. 622

85TH CONGRESS, 1st Session | SENATE | REPORT No. 607

AUTHORIZING RESEARCH IN WEATHER MODIFICATION BY THE NATIONAL SCIENCE FOUNDATION

JULY 11 (legislative day, JULY 8), 1957.—Ordered to be printed

Mr. BIBLE, from the Committee on Interstate and Foreign Commerce, submitted the following

REPORT

[To accompany S. 86]

The Committee on Interstate and Foreign Commerce, to whom was referred the bill (S. 86) to provide for an experimental research program in cloud modification, having considered the same, report favorably thereon with amendments and recommend that the bill, as amended, do pass.

HEARINGS

This bill proposes a research program in weather modification. Events of the year suggest that nothing could be more timely.

Hearings on the bill have been held on 2 separate days during this session of Congress. Information developed at these hearings by extensive testimony from scientists, farmer organizations, State and municipal officials, businessmen, electric utilities, Congressmen sponsoring companion bills to S. 86 (H. R. 3631, H. R. 5232, H. R. 5954, and H. R. 5958), and Federal agency representatives emphasized the importance of and the need for legislation establishing a program of basic and applied research in the field of weather modification.

Your committee has reviewed the hearings and has amended the bill to change its organizational methods, but not its objectives.

The interested departments and agencies of the Government have submitted reports favorable to the objectives of the bill, but recommending a variety of administrative methods for carrying out the program. Almost unanimously they recommended that the program be placed in the hands of a permanent operating agency of government, most mentioning specifically the National Science Foundation.

Testimony from nongovernment witnesses indicated further need for a scientifically controlled program of research in both the basic and applied aspects of the program. Individual witnesses representing actual users of present cloud-seeding techniques gave ample

evidence of the widespread interest and use of present methods, and their belief that this science is but in its infancy.

This activity is in the field of snow pack increase, hail suppression together with expressed interest in the possibilities of suppression of fog as well as rain increase. The Department of Agriculture is investigating the possibility of suppression of lightning in the western forest areas, where up to 74 percent of the forest fires are lightning caused.

After carefully examining all testimony offered, your committee has come to the conclusion that it is vitally necessary to investigate every possibility of increasing rainfall or snow pack for both power and agricultural uses and diminishing or suppressing the hazards of hail, lightning, fog, and tornadoes.

The Presidential Advisory Committee on Weather Control, in evaluating studies and reports fron operations on the windward slopes of the western mountain regions of the United States, has established that seeding operations have produced significant increases in precipitation over that which might have been expected without seeding.

However, as the interim report of the Advisory Committee on Weather Control pointed out, it has not been proven that these scientific conclusions can be drawn for the Great Plains, the Southwest, or the Eastern States. Considerable commercial activity has been carried out in all these areas for rain increase for agricultural and forest purposes as well as for water supplies for cities and towns. It has been difficult to evaluate them under prevailing practices.

In order to arrive at correct conclusions, scientifically controlled experiments are necessary. These experiments must include not only the applied or actual field tests with resulting correct data, but also the basic research to develop correctness of present techniques and to develop new methods and ideas. Testimony from scientists indicated that present scientific knowledge about precipitation and its processes is very meager.

In short, testimony indicated that much was yet to be learned about the entire process of precipitation and that in searching for such information, many other facts might well come to light about basic weather phenomena.

Among the unchallenged and competent evidence on the need for additional research was a statement of Dr. Robert D. Fletcher, president of the American Meteorological Society, released on April 30, 1957.

American Meteorological Society

Office of the Executive Secretary

BOSTON, MASS.

Dr. Robert D. Fletcher, president of the American Meteorological Society, today released a statement on weather modification which outlines the general opinion of the field of meteorology on this matter of great public interest. The society, composed of nearly 6,500 members, is the professional and scientific organization which represents weathermen throughout the Americas. Its membership is made up of meteorologists from private industry, the universities, and the Government weather services.

The society has adopted a policy of issuing statements, to be reviewed annually, on a number of weather problems of vital interest to the public. These include the detection, tracking, and prediction of tornadoes and hurricanes, long-range forecasting, fallout of radioactive debris, and other subjects.

The statement on weather modification, approved by the society's council, is as follows:

"The council of the American Meteorological Society has assumed the responsibility for issuing periodic statements on the scientific aspects of weather modification and control. Two previous statements were issued in 1951 and in 1953. In view of the additional information on this subject that has become available in the interim, the council deems it desirable to issue a revised statement of its opinion at this time.

"1. The seeding of a supercooled cloud with dry ice will usually convert at least a portion of the cloud to ice crystals. Under appropriate conditions, such seeding may release variable amounts of precipitation from fairly deep and active cumulus clouds in which the natural release of precipitation has not already started. Small, inactive cumulus clouds are usually dissipated when they are seeded with dry ice. Holes or valleys may be produced in supercooled layer clouds or supercooled fogs by seeding them with dry ice.

"2. The injection of water drops or hygroscopic salt particles into active, warm (nonsupercooled) cumulus clouds may release some rain. Small, inactive, warm cumulus may often be partially or completely dissipated by seeding them from above with water drops or other particles; such dissipation may occasionally be accompanied by the release of very light rain.

"3. In some cases warm fog and stratus may be dissipated in restricted regions by the use of certain hygroscopic materials.

"4. At temperatures below about —5° C. silver iodide crystals are known to affect supercooled clouds in much the same way as dry ice. The frequent absence of clear-cut results following the operation of ground-based silver iodide generators is believed to be due to one or more of the following causes: (*a*) the failure of the seeding material to reach the supercooled clouds, (*b*) the absence of clouds that could be affected by seeding, (*c*) the decay of the silver iodide, (*d*) the presence of an ample supply of natural ice crystals, (*e*) topographical influences which defy quantitative measurement.

"5. Cloud seeding acts only to trigger the release of precipitation from existing clouds. The release of substantial amounts of precipitation by either natural or artificial means requires the preexistence of an extensive moisture supply in the form of moist air currents and of active cloud-forming processes. For this reason the meteorological conditions most favorable for the artificial release of precipitation are very much the same as those which usually lead to the natural release of precipitation. This factor plus the extreme natural variability of precipitation makes the evaluation of the effects of seeding difficult and often inconclusive.

"6. Evaluations performed by independent agencies have yielded reasonably convincing evidence of increases of precipitation due to the operation of ground-based silver iodide generators only for operations conducted in cold weather in regions where forced lifting of the air over a mountain range is an important factor. No convincing evidence has been presented which indicates that ground-based silver iodide seeding affects the amount or character of the precipitation over flat country. This does not prove that there are no such effects but suggests that, if present, they are too small to be detected by statistical analyses of data available to this date.

"7. In the absence of a truly quantitative theory of precipitation, the best present means of obtaining a quantitative estimate of the effect of seeding on precipitation is through the statistical evaluation of randomized cloud seeding experiments. The randomization is necessary to insure valid interpretations of the results and a long series of such experiments may be necessary to detect small effects.

"8. Present knowledge of atmospheric processes offers no real basis for the belief that the weather or climate of a large portion of the country can be significantly modified by cloud seeding. It is not intended to rule out the possibility of large-scale modifications of the weather at some future time, but it is believed that, if possible at all, this will require methods that alter the large-scale atmospheric circulations, possibly through changes in the radiation balance.

"9. All cloud seeding operations should be considered as experiments since the techniques are still under development and there is no sound basis for the quantitative estimation of the results in advance of the operation. As experiments they should be designed primarily to yield optimum scientific results. There is good reason to believe that improved returns from cloud seeding will result from a sound experimental approach and this should be fostered by all concerned."

* * * * *

AMENDMENTS

In amending the bill, your committee did not change its objectives but changed its administrative and organizational methods in line with the bulk of the testimony offered at the hearings.

First, in line with testimony offered by governmental agencies, general administrative responsibility was given to the National Science Foundation instead of the Advisory Committee on Weather Control. Presently in charge of basic research programs for the Government, the National Science Foundation seemed to be the logical agency to carry out the program.

The scope of the program was enlarged from one restricted to cloud seeding to one embracing other phases of weather modification including the suppressing or diminishing of hail, lightning, fog, smog, tornadoes, and other weather phenomena. Scientific testimony indicated that in basic research on one topic, what is referred to as

"fortunate accidents" occur and these might well lead to discoveries in other fields.

Under the National Science Foundation Act of 1950, the Foundation may not engage in research directly. Therefore, provisions in the bill would permit the National Science Foundation to execute the program by making grants to, or contracts with, public or private institutions or agencies, as well as cooperative programs with States. The National Science Foundation would also be able to arrange with other governmental agencies for handling of the applied or field research aspects of the program. Such field research would be supplementary to the basic research as determined by the National Science Foundation to be important to purposes of the act.

In determining the content of the program, it is expected that the National Science Foundation would establish a special commission, as set forth in section 9 (a) and (b), or other committee, for the purposes of formulating an overall research program in the field of weather modification. This group will recommend which portions of the field should be investigated from a basic aspect, and which should be applied or field research. The National Science Foundation, after consulting an interagency group of governmental agencies and departments, would determine the best possible division of the applied research program and arrange responsibility for this portion of the program.

Presently, no Federal agency has specific legislative authority or funds to carry out a program of basic and applied research in the field of weather modification. In addition to the lack of legislation, certain areas of investigation and experimentation are of such magnitude and legal status as to make it difficult to be conducted by other than Federal Government operation. Thus, your committee recommends a research program that will yield scientifically verifiable answers to the many questions in the important field of weather modification.

DEPARTMENTAL REPORTS

In the interest of brevity in this report, pertinent paragraphs of the departmental letters are made a part of this report, with the complete text appearing in the printed hearings.

ADVISORY COMMITTEE ON WEATHER CONTROL

My Dear Mr. Chairman: * * * The Advisory Committee on Weather Control is in favor of the objectives of Senate bill 86 * * *.

The Advisory Committee, in its first interim report to President Eisenhower on February 8, 1956, strongly recommended the development of a long-range program in basic and applied research in cloud physics under scientifically controlled conditions * * *.

* * * the Committee decided to ascertain from its six Federal agency members expressions of their interest as to which would be the most appropriate agency to undertake the administration of the Federal portion of the program * * *. (*)

Howard T. Orville, *Chairman.*

(*Note.—Pertinent sentences of these letters appear below.)

Excerpts from letters to the Advisory Committee as noted above:

Department of Agriculture

* * * Our preference would be that the National Science Foundation assume the major responsibility for developing and coordinating a long-range program * * *.

E. T. Benson.

Department of Commerce

* * * For this reason, I emphasize the importance of placing the planning and administration of research in weather modification under the immediate supervision of highly competent scientist-administrators who can best design and conduct this important research program.

Louis S. Rothschild.

Department of Defense

* * * believes that the National Science Foundation is particularily qualified to execute such a program in collaboration with other interested Federal agencies.

C. E. Wilson.

Department of Health, Education, and Welfare

* * * The National Science Foundation is well equipped to administer the activity * * *.

M. B. Folsom.

Department of the Interior

* * * Therefore, for the administration of such a program, we recommend the National Science Foundation, a scientific bureau experienced in weighing research proposals and allocating Federal funds for research purposes.

Hatfield Chilson.

National Science Foundation

* * * In accordance with established policy, the Foundation would, if requested, consider taking the lead among Federal agencies in establishing and carrying out a general plan for research toward a better understanding of the subject. In that event, the Foundation would expect assurances of cooperation from the interested Federal agencies, and expressions of their interest and willingness to participate in carrying out such plans for practical developments as might arise.

Alan T. Waterman.

DEPARTMENT OF AGRICULTURE

Dear Senator Magnuson: * * * We do not advise enactment of the bill as the broad research program planning can be accomplished by the Advisory Committee on Weather Control without additional authority and without extending its life. Detailed program planning should be done by the agency or agencies that are ultimately given the responsibility for experimentation in this field * * *.

True D. Morse.

DEPARTMENT OF THE AIR FORCE

Dear Mr. Chairman: * * * The Department of Defense has no objection to the proposed legislation. * * *

* * * The Department of Defense would favor a cooperative Federal-State research program in cloud modification, provided: (*a*) The program is conducted by the appropriate nondefense agency of the Federal Government, the States and their universities, and private agencies; and (*b*) the program is truly scientific in nature and places major emphasis and priority on basic and applied research on the cloud physics and meteorological problems which must be solved before there can be sufficient understanding and knowledge to realize any significant potential which may exist for the artificial production of precipitation.

The Department of Defense suggests that such a program should be administered by a permanent, interested Federal agency such as the National Science Foundation, the Department of Interior, the Department of Agriculture, or the Department of Commerce. * * *

JAMES H. DOUGLAS,
Under Secretary.

DEPARTMENT OF COMMERCE

DEAR MR. CHAIRMAN: * * * In view of the foregoing, it is our conviction that a more expeditious and economical approach to the development of weather modification techniques would be to center responsibility for the planning and coordination of an adequate program in the National Science Foundation and to authorize that agency to make arrangements for research activities by those private and public institutions that are in a position to make the best use of scientific personnel and facilities available. We are convinced this solution to the problem would result in the required comprehensive program at a reasonable cost and would foster cooperation with private organizations and the States in the development of this important meteorological phenomena. * * *

For the above reasons, the Department of Commerce recommends against enactment of S. 86. * * *

H. C. MCCLELLAN,
Acting Secretary of Commerce.

DEPARTMENT OF THE INTERIOR

DEAR SENATOR MAGNUSON: * * * We recommend the enactment of the bill, provided it is amended to conform with the expression of views contained in this report * * *.

Research of this kind is a long-term program and is a definite action plan. For this reason, we believe that the provisions of the bill can be administered better by a permanent agency of the Government than by a temporary agency * * *.

* * * We recommend, however, that basic research be placed in some agency, such as the National Science Foundation, which is devoted to administering scientific research programs and which has had substantial experience with working with education institutions and other public and private organizations. Widespread experimental and productive cloud seeding should perhaps be handled by the Weather Bureau or the Department of Agriculture.

With the uncertainty about the amount of money that might be needed for this purpose, it would be better to authorize such expenditures as might be needed rather than stipulating a $5 million author-

ization for the proposed program. The amounts of money would then be determined by budget clearance and Appropriations Committee action. * * *

FRED G. AANDAHL,
Assistant Secretary of the Interior.

NATIONAL SCIENCE FOUNDATION

DEAR MR. CHAIRMAN: * * * My final point is that the Advisory Committee's interim report expresses findings that are rational and realistic with reference to the research, both basic and applied, that is needed. This must be done both in the laboratories and in the field. In keeping with these findings, the National Science Foundation is already encouraging and supporting research in atmospheric physics, in both the laboratory and the field, and in cooperating with other Federal agencies to the end that research results may be quickly tested and applications developed. Moreover, it is in process of expanding its program in this field, with the advice of a competent panel of scientists now being established. * * *

* * * It would be my view, therefore, that your committee should determine, before recommending action on S. 86, whether the objectives of the bill could not be attained through existing, permanent agencies, without special authorization, rather than adding such responsibility to the present duties of the Advisory Committee on Weather Control. * * *

DR. PAUL E. KLOPSTEG.

○

Calendar No. 622

85TH CONGRESS
1ST SESSION

S. 86

[Report No. 607]

IN THE SENATE OF THE UNITED STATES

JANUARY 7 (legislative day, JANUARY 3), 1957

Mr. CASE of South Dakota (for himself, Mr. ANDERSON, Mr. MAGNUSON, Mr. WATKINS, Mr. MONRONEY, Mr. SMATHERS, Mr. BIBLE, Mr. THURMOND, Mr. YARBOROUGH, Mr. BRICKER, Mr. SCHOEPPEL, Mr. BUTLER, Mr. POTTER, Mr. PURTELL, Mr. PAYNE, Mr. COTTON, and Mr. CARROLL) introduced the following bill; which was read twice and referred to the Committee on Interstate and Foreign Commerce

JULY 11 (legislative day, JULY 8), 1957

Reported by Mr. BIBLE, with amendments

[Strike out all after the enacting clause and insert the part printed in italic]

A BILL

To provide for an experimental research program in cloud modification.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

~~That, for a period of five years following the effective date of this Act, the Advisory Committee on Weather Control be authorized and directed to formulate a program of experimental research in the field of cloud modification with special reference to areas in the States that have suffered from shortage of natural rainfall.~~

~~SEC. 2. The experimental research program authorized~~

~~by this Act shall be carried on either by contracts between the Advisory Committee on Weather Control and private or public agencies and through cooperative programs with State agencies, including land-grant colleges or other State agencies to be designated by the governor of the State.~~

~~SEC. 3. There is hereby authorized to be appropriated a sum not exceeding $5,000,000 for the accomplishment of the program herein authorized: *Provided*, That of the amount appropriated annually during the five years for which this program is authorized, one-fourth shall be available for that part of the program to be accomplished by contract and three-fourths shall be available for the cooperative program to be matched equally by the States.~~

~~SEC. 4. This Act may be cited as the "Cloud Modification Research Act of 1957".~~

The National Science Foundation is authorized and directed to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, or other weather phenomena, and to report annually to the President and the Congress thereon. In conducting such studies, the Foundation shall consult with meteorologists and scientists in private life and with agencies of Government interested in, or affected

1 *by, experimental research in the field of weather control. Re-*
2 *search programs to carry out the purposes of this Act by*
3 *the National Science Foundation, and by other Government*
4 *agencies or departments, may be accomplished through con-*
5 *tract with, or grants to, private or public institutions or agen-*
6 *cies, including but not limited to cooperative programs with*
7 *any State through such instrumentalities as may be desig-*
8 *nated by the governor of such State.*

9 *Sec. 2. For the purposes of this Act, the Foundation is*
10 *authorized to accept as a gift, money, material, or services:*
11 *Provided, That any such gift may, if the donor so specifies,*
12 *be restricted or limited for use in connection with certain*
13 *projects or areas. Other agencies of the Government are*
14 *authorized to loan, without reimbursement, and the Founda-*
15 *tion is authorized to receive, such property and personnel as*
16 *may be deemed useful, with the approval of the Director of*
17 *the Bureau of the Budget. In addition to the authority con-*
18 *tained herein, the National Science Foundation, for the pur-*
19 *poses of this Act, may utilize any of the powers granted by*
20 *the National Science Foundation Act of 1950 (42 U. S. C.*
21 *1861–75).*

22 *Sec. 3. The Advisory Committee on Weather Control is*
23 *abolished effective December 31, 1957, and its functions,*
24 *duties, and records and any unexpended funds are transferred*

1 *to the National Science Foundation and there is authorized*
2 *to be appropriated to the National Science Foundation, such*
3 *amounts as are necessary to carry out the purposes of this*
4 *Act.*

Amend the title so as to read "A bill to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes."

Calendar No. 622

85TH CONGRESS
1ST SESSION

S. 86

[Report No. 607]

A BILL

To provide for an experimental research program in cloud modification.

By Mr. CASE of South Dakota, Mr. ANDERSON, Mr. MAGNUSON, Mr. WATKINS, Mr. MONRONEY, Mr. SMATHERS, Mr. BIBLE, Mr. THURMOND, Mr. YARBOROUGH, Mr. BRICKER, Mr. SCHOEPPEL, Mr. BUTLER, Mr. POTTER, Mr. PURTELL, Mr. PAYNE, Mr. COTTON, and Mr. CARROLL

JANUARY 7 (legislative day, JANUARY 3), 1957
Read twice and referred to the Committee on Interstate and Foreign Commerce

JULY 11 (legislative day, JULY 8), 1957
Reported with amendments

Aug. 5, 1957

16. WEATHER CONTROL. Passed as reported S. 86, to authorize research in cloud modification. p. 12314

17. MINERALS. Passed as reported S. 2039, to clarify the definition of labor required to be performed to hold unpatented mining claims on Federal land. pp. 12314-15

18. CENSUS. Passed as reported S. 1631, to amend generally the census laws. pp. 12326-7

19. BUILDINGS. Passed without amendment S. 2108, to authorize GSA to name, rename, or designate any building under its control. p. 12331

20. FEED GRAINS. Agreed to S. Res. 168, to print as a Senate document this Department's report on the feed grain program. p. 12340

21. RESEARCH; LAND. Agreed to S. Res. 169, to print as a Senate document a Library of Congress survey, "National Policies on Federal Landownership." p. 12340

Passed as reported S. 1962, to convey certain ARS land near Bowie, Md., to the Perkins Chapel Methodist Church. p. 12342

22. FISH; RICE. Passed as reported S. 1552, to authorize this Department to establish a research program to develop methods for the commercial production of fish on flooded rice acreage. pp. 12341-2

23. FOREIGN AFFAIRS. Both Houses received the President's message on activities to promote the peace and stability of the Middle East, through June 30, 1957. pp. 12299, 12369

24. ROADS. Sen. Neuberger inserted an editorial, "Last Chance on Billboards," urging action on the bills to control signboards along the Federal interstate highway system. p. 12307

25. ELECTRIFICATION. Sen. Langer inserted a resolution from the West River Mutual Aid Telephone Corp of N.D., opposing any increase in REA interest rates. pp. 12299-12300

Sen. Langer inserted a series of resolutions adopted by the N.D. Rural Electric Cooperative Ass'n, opposing any increase in REA interest rates; supporting construction of a high Federal dam at Hells Canyon; urging more loan funds for generation and transmission; supporting the preference concept; supporting H.R. 965, to limit repayment for electrification (on multi-purpose projects) to those costs related to such purposes; urging passage of the bill to allow TVA to sell its own bonds; urging development of the Yellowtail project on the Bighorn River; urging establishment of a "capital budget" accounting system; opposing private power firms "propaganda" advertising; urging further study on the allocation of Missouri River basin waters; and commending REA Administrator Hamil. pp. 12300-1

At the request of Sen. Clark, passed over S. 2406, to authorize the construction of works of improvement in the Niagara River. p. 12310

At the request of Sen. Barrett, passed over H.R. 8643, to authorize the construction of works of improvement in the Niagara River. p. 12345

Sen. Stennis, as acting Majority leader, assured Sens. Case, S.D., and Kefauver, that the TVA and Niagara power bills would be presented to the policy committee for consideration as to the disposition of the bill at the conclusion of the Civil Rights debate. pp. 12347-8

26. FISCAL POLICY. Sen. Bush inserted a series of articles on tight credit, lower prices, and the Administration's fiscal policies. pp. 12302-4

HOUSE

27. ACREAGE ALLOTMENTS. Passed without amendment H.R. 8030, to eliminate the requirement that notice of intention not to plant the full acreage allotment must be filed with the county committee in order for a farmer to receive credit for future acreage allotment purposes. p. 12374

28. FORESTRY; WATERSHEDS; COTTON; COUNTY COMMITTEES. The Agriculture Committee reported the following bills: p. 12446
H.R. 580, with amendment, to authorize the exchange of certain land under the jurisdiction of the Forest Service with Mo. (H. Rept. 989).
H.R. 5497, with amendment, to subject recreational and fish and wildlife development projects to certain conditions in order to receive Federal assistance under the Watershed Protection and Flood Prevention Act (H. Rept. 990).
H.R. 6765, without amendment, to repeal the prohibitions against cotton acreage reports based on farmers' planting intentions (H. Rept. 991).
H.R. 8508, with amendment, to provide two county committees elected under the Soil Conservation and Domestic Allotment Act for certain counties in Minn. and Iowa (H. Rept. 994).

29. PERSONNEL. The Post Office and Civil Service Committee reported with amendment H.R. 4640, to amend the Civil Service Retirement Act to permit persons transferring to non-Act positions to retain voluntary contribution accounts (H. Rept. 1000). p. 12446

30. NATURAL RESOURCES. The Judiciary Committee reported with amendment S.J. Res. 35, to provide for the observance and commemoration of the 50th anniversary of the first conference of State governors for the protection of the natural resources of the U.S.. (H. Rept. 988). p. 12446

31. FIBER. The Interstate and Foreign Commerce Committee reported with amendment H.R. 469, to protect producers and consumers against misbranding and false advertising of the fiber content of textile fiber products (H. Rept. 986). p. 12446
Passed with amendment H.R. 7096, to exempt istle and Tampico fiber from the Tariff Act of 1930. pp. 12433-34

32. FARM PROGRAM. Rep. Harvey defended the farm program against recent attacks, citing accomplishments during the past four years. p. 12438
Rep. McGovern urged increased distribution of surplus foods, and suggested five methods for "better utilization of food surpluses." p. 12436

33. OLEOMARGARINE. Passed over, on objections by Rep. Andresen, Marshall, and Bass, H.R. 912, to provide for the serving of oleomargarine or margarine in the Navy ration. The bill was thus stricken from the consent calendar. p. 12369

34. PUBLIC LANDS. Passed as reported H.R. 8054, to provide for the leasing of oil and gas deposits in lands beneath inland navigable waters in Alaska. p. 12370
Passed as reported H.R. 2237, to authorize the transfer of certain property of VA to the Johnson City (Tenn.) National Farm Loan Assoc. and the E. Tenn. Production Credit Assoc., local units of the Farm Credit Administration. p. 12371

colon and *"And provided further,* That the marriage to her United States citizen fiance, Sgt. Dewey Kocherhans, shall occur not later than 6 months following the date of the enactment of this act."; so as to make the bill read:

Be it enacted, etc., That, notwithstanding the provision of section 212 (a) (9) of the Immigration and Nationality Act, Rosa Sigl may be issued a visa and be admitted to the United States for permanent residence if she is found to be otherwise admissible under the provisions of that act: *Provided,* That this exemption shall apply only to a ground for exclusion of which the Department of State or the Department of Justice has knowledge prior to the enactment of this act: *And provided further,* That the marriage to her United States citizen fiance, Sgt. Dewey Kocherhans, shall occur not later than 6 months following the date of the enactment of this act.

The amendments were agreed to.

The bill was ordered to be engrossed for a third reading, read the third time, and passed.

ADMISSION INTO THE UNITED STATES OF CERTAIN ALIENS

The Senate proceeded to consider the joint resolution (H. J. Res. 323) to facilitate the admission into the United States of certain aliens, which had been reported from the Committee on the Judiciary with an amendment on page 2, line 3, after "SEC. 3.", to strike out "For the purposes of the Immigration and Nationality Act, Sofia Kavadias shall be deemed to be a nonquota immigrant" and insert "For the purposes of sections 203 (a) (3) and 205 of the Immigration and Nationality Act, Sofia Kavadias shall be held and considered to be the natural-born alien child of Mr. and Mrs. Georgios Kavadias, lawful permanent residents of the United States."

The amendment was agreed to.

The amendment was ordered to be engrossed and the joint resolution to be read the third time.

The joint resolution was read the third time, and passed.

REMOVAL OF TIMBER FROM LANDS ACQUIRED BY THE UNITED STATES

The bill (H. R. 7522) to authorize the extension of certain rights to remove timber from lands acquired by the United States was considered, ordered to a third reading, read the third time, and passed.

JOHN J. FARRELLY

The Senate proceeded to consider the bill (H. R. 5341) for the relief of John J. Farrelly, which had been reported from the Committee on Interior and Insular Affairs with amendments on page 1, line 4, after the name "Missouri", to insert "or his assignees"; in line 9, after the figures "053934", to strike out "057169,", and, in line 11, after the word "act", to insert "but no extension shall be granted by this act with respect to any lease on which rental payments due on the date of approval of this act are not paid within 90 days thereafter."

The amendments were agreed to.

The amendments were ordered to be engrossed and the bill to be read a third time.

The bill was read the third time, and passed.

PARTICIPATION BY THE UNITED STATES IN THE INTERPARLIAMENTARY UNION

The bill (S. 2515) to amend the act of June 28, 1935, entitled "An act to authorize participation by the United States in the Interparliamentary Union" was considered, ordered to be engrossed for a third reading, read the third time, and passed, as follows:

Be it enacted, etc., That section 1 of the act of June 28, 1935, as amended (49 Stat. 425; 22 U. S. C. 276) is hereby amended to read as follows: "An appropriation of $33,000 annually is hereby authorized, $18,000 of which shall be for the annual contribution of the United States toward the maintenance of the Bureau of the Interparliamentary Union for the promotion of international arbitration; and $15,000, or so much thereof as may be necessary, to assist in meeting the expenses of the American group of the Interparliamentary Union for each fiscal year for which an appropriation is made, such appropriation to be disbursed on vouchers to be approved by the President and the executive secretary of the American group."

AMENDMENT OF DISTRICT OF COLUMBIA HOSPITAL CENTER ACT—BILL PASSED OVER

The bill (S. 1908) to amend the District of Columbia Hospital Center Act in order to extend the time and increase the authorization for appropriations under such act, was announced as next in order.

Mr. CHAVEZ. Over.

The PRESIDING OFFICER. The bill will be passed over.

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

The Senate proceeded to consider the joint resolution (S. J. Res. 85) to amend the act of Congress approved August 7, 1935, covering United States contributions to the International Council of Scientific Unions and certain associated unions, which had been reported from the Committee on Foreign Relations with an amendment in line 3, after the word "Law", to strike out "255" and insert "253", so as to make the joint resolution read:

Resolved, etc., That Public Law 253, 74th Congress, is hereby amended by striking out the figure "$9,000" in the section dealing with the International Council of Scientific Unions and inserting in lieu thereof the figure "$65,000."

The amendment was agreed to.

The joint resolution was ordered to be engrossed for a third reading, read the third time, and passed.

RIO GRANDE REHABILITATION PROJECT, TEXAS—BILL PASSED OVER

The bill (S. 2120) to authorize the Secretary of the Interior to construct, rehabilitate, operate and maintain the lower Rio Grande rehabilitation project, Texas, Mercedes division, was announced as next in order.

Mr. CLARK. Over.

The PRESIDING OFFICER. The bill will be passed over.

APPOINTMENT OF MEMBERS OF THE SENATE TO ATTEND MEETING OF COMMONWEALTH PARLIAMENTARY ASSOCIATION

The resolution (S. Res. 160) authorizing the appointment of four Members of the Senate to attend the next general meeting of the Commonwealth Parliamentary Association to be held in India was considered and agreed to, as follows:

Resolved, That the Vice President is authorized to appoint four Members of the Senate to attend the next general meeting of the Commonwealth Parliamentary Association to be held in India on the invitation of the Indian branch of the association, and to designate the chairman of the delegation. The expenses incurred by the members of the delegation and staff appointed for the purpose of carrying out this resolution shall not exceed $15,000 and shall be reimbursed to them from the contingent fund of the Senate upon submission of vouchers approved by the chairman of the delegation.

MEETING OF COMMONWEALTH PARLIAMENTARY ASSOCIATION IN INDIA

The concurrent resolution (S. Con. Res. 36) authorizing the appointment of 4 Members each of the 2 Houses to attend general meeting of the Commonwealth Parliamentary Association to be held in India was considered and agreed to, as follows:

Resolved by the Senate (the House of Representatives concurring), That the Vice President and the Speaker of the House of Representatives are authorized to appoint 4 Members of the Senate and 4 Members of the House of Representatives, respectively, to attend the next general meeting of the Commonwealth Parliamentary Association to be held in India on the invitation of the Indian branch of the association and to designate the chairmen of the delegations from each of the Houses to be present at such a meeting. The expenses incurred by the members of the delegations and staff appointed for the purpose of carrying out this concurrent resolution shall not exceed $15,000 for each delegation and shall be reimbursed to them from the contingent fund of the House of which they are Members, upon submission of vouchers approved by the chairman of the delegation of which they are members.

INCREASE OF FEES CHARGED ON TRANSACTIONS ON NATIONALLY RECOGNIZED EXCHANGES—BILL PASSED OVER

The bill (S. 2520) to amend section 31 of the Securities and Exchange Act of 1934, was announced as next in order.

Mr. BARRETT. Over.

The PRESIDING OFFICER. The bill will be passed over.

NEWPORT IRRIGATION DISTRICT, NEBRASKA

The bill (H. R. 3071) to authorize the Secretary of the Interior to enter into and to execute amendatory contract with the Newport Irrigation District, Nebraska, was considered, ordered to a third reading, read the third time, and passed.

RESEARCH PROGRAM IN CLOUD MODIFICATION

The Senate proceeded to consider the bill (S. 86) to provide for an experimental research program in cloud modification, which had been reported from the Committee on Interstate and Foreign Commerce with an amendment to strike out all after the enacting clause and insert:

The National Science Foundation is authorized and directed to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, or other weather phenomena, and to report annually to the President and the Congress thereon. In conducting such studies, the Foundation shall consult with meteorologists and scientists in private life and with agencies of Government interested in, or affected by, experimental research in the field of weather control. Research programs to carry out the purposes of this act by the National Science Foundation, and by other Government agencies or departments, may be accomplished through contract with, or grants to, private or public institutions or agencies, including but not limited to cooperative programs with any State through such instrumentalities as may be designated by the governor of such State.

SEC. 2. For the purposes of this act, the Foundation is authorized to accept as a gift, money, material, or services: *Provided,* That any such gift may, if the donor so specifies, be restricted or limited for use in connection with certain projects or area. Other agencies of the Government are authorized to loan, without reimbursement, and the Foundation is authorized to receive, such property and personnel as may be deemed useful, with the approval of the Director of the Bureau of the Budget. In addition to the authority contained herein, the National Science Foundation, for the purposes of this act, may utilize any of the powers granted by the National Science Foundation Act of 1950 (42 U. S. C. 1861–1875).

SEC. 3. The Advisory Committee on Weather Control is abolished effective December 31, 1957, and its functions, duties, and records and any unexpended funds are transferred to the National Science Foundation and there is authorized to be appropriated to the National Science Foundation such amounts as are necessary to carry out the purposes of this act.

The amendment was agreed to.

The bill was ordered to be engrossed for a third reading, read the third time, and passed.

The title was amended, so as to read: "A bill to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes."

Mr. CASE of South Dakota. Mr. President, I ask unanimous consent that I may place at this point in the RECORD a statement relative to the bill just passed.

There being no objection, the statement was ordered to be printed in the RECORD, as follows:

STATEMENT BY SENATOR FRANCIS CASE OF SOUTH DAKOTA

Mr. President, this bill authorizes the National Science Foundation to complete the evaluation work of the Advisory Committee on Weather Control and to undertake an orderly research program in weather modification.

As I had introduced the bill, the program would have been carried on by the advisory committee. The majority of the Federal agencies concerned with potentialities of the program, however, recommended that the research program be assigned to the agency which now coordinates and conducts governmental research—the National Science Foundation. The Chairman of the Advisory Committee, Capt. Howard Orville, concurred in this thought, and the bill was appropriately amended.

The possible importance of this bill to the Nation is tremendous. We spend hundreds of millions of dollars to counteract and alleviate weather-caused disasters. Individuals and businesses spend and suffer even more.

To give some idea of the possibilities of cloud modification, I quote these sentences from a statement issued by the Council of the American Meteorological Society on April 30, 1957:

"1. The seeding of a supercooled cloud with dry ice will usually convert at least a portion of the cloud to ice crystals. Under appropriate conditions, such seeding may release variable amounts of precipitation. * * * Holes or valleys may be produced in supercooled clouds or supercooled fogs by seeding them with dry ice.

"2. The injection of water drops or hydroscopic salt particles into active, warm (nonsupercoolod) cumulus clouds may release some rain. * * *

"3. In some cases warm fog and stratus may be dissipated in restricted regions by the use of certain hygroscopic materials.

"4. At temperatures below about −5° centigrade silver iodide crystals are known to affect supercooled clouds in much the same way as dry ice. * * *

"5. Cloud seeding acts only to trigger the release of precipitation from existing clouds. * * *

"6. No convincing evidence has been presented which indicates that ground-based silver iodide seeding affects the amount or character of precipitation over flat country. (Mountain country is different.)

"7. * * *

"8. * * *

"9. All cloud-seeding operations should be considered as experiments since the techniques are still under development and there is no sound basis for the quantitative estimation of the results in advance of the operation. * * * There is good reason to believe that improved returns from cloud seeding will result from a sound experimental approach and this should be fostered by all concerned."

This bill, S. 86, Mr. President, is designed to provide that "sound experimental approach" which the American Meteorological Society states "should be fostered by all concerned."

It is the result of extensive hearings and careful deliberation by the Senate Committee on Interstate and Foreign Commerce.

I urge all those interested to get a copy of Report No. 607, on this bill, S. 86, and a copy of the hearings if they have not been exhausted.

When a great deal of today's legislation has been passed and forgotten, it is my earnest conviction that what this Congress does to authorize this orderly experimentation and evaluation of efforts in cloud modification will have lasting significance for conditions of fog, smog, drought, floods, and hurricanes. What this would mean for the welfare of agriculture, commerce, industry, defense, and other material and human concerns is beyond our power today to estimate. I thank the Committee and all who have helped in consideration and passage of the bill.

MINING CLAIMS ON FEDERAL LANDS

The bill (S. 2039) to clarify the requirements with respect to the performance of labor imposed as a condition for the holding of mining claims on Federal lands pending the issuance of patents therefor was announced as next in order.

Mr. BARRETT. Mr. President, reserving the right to object, may be have an explanation of the bill.

Mr. BIBLE. The purpose of the bill is to broaden the type of labor that can be considered for the performance of the annual assessment work on mining claims. Great advances have been made in modern-day mineral exploration through geophysical and geochemical means. My bill, S. 2039, would give recognition to these scientific advances by permitting their use to be considered as labor, for the fulfillment of the annual assessment work on mining claims. Geophysical and geochemical explorations are now on a scientific basis and are well established and well recognized in the mining world.

It is not contemplated that the new type of work be used to supplant the historic requirement for a bona fide discovery. A discovery of a mineral of such quantity and quality as to warrant its development by a prudent man would still be necessary for the location of mining claims if S. 2039 becomes law. A bona fide discovery of that nature is inherent in our mining law, and this requirement would not be changed by the measure under discussion. The bill goes only to the requirement that at least $100 worth of labor and materials must be expended annually in the development of a mining claim, once a discovery has been made, in order that the locator may maintain property rights in it. The measure was introduced and was reported by the Committee on Interior and Insular Affairs solely for the purpose of taking into account modern-day methods of proving up mining claims.

Mr. BARRETT. Mr. President, will the Senator from Nevada yield?

Mr. BIBLE. I am delighted to yield.

Mr. BARRETT. I do not intend to object to consideration of the bill. But my attention has been called to the fact that there is no definition in the bill of what constitutes the geophysical work or the geological work which may be done in order to comply with the law under this measure. Perhaps the House committee in its report may outline precisely what type of work is intended to be included.

Mr. BIBLE. Mr. President, I think the suggestion of the Senator from Wyoming

S. 86

AN ACT

85TH CONGRESS
1ST SESSION

S. 86

IN THE HOUSE OF REPRESENTATIVES

AUGUST 6, 1957

Referred to the Committee on Interstate and Foreign Commerce

AN ACT

To provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*
3 The National Science Foundation is authorized and di-
4 rected to initiate and support a program of study, research,
5 and evaluation in the field of weather modification, giving
6 particular attention to areas that have experienced floods,
7 drought, hail, lightning, fog, tornadoes, or other weather
8 phenomena, and to report annually to the President and the
9 Congress thereon. In conducting such studies, the Founda-
10 tion shall consult with meteorologists and scientists in private

1 life and with agencies of Government interested in, or affected
2 by, experimental research in the field of weather control. Re-
3 search programs to carry out the purposes of this Act by
4 the National Science Foundation, and by other Government
5 agencies or departments, may be accomplished through con-
6 tract with, or grants to, private or public institutions or agen-
7 cies, including but not limited to cooperative programs with
8 any State through such instrumentalities as may be desig-
9 nated by the governor of such State.

10 SEC. 2. For the purposes of this Act, the Foundation is
11 authorized to accept as a gift, money, material, or services:
12 *Provided,* That any such gift may, if the donor so specifies,
13 be restricted or limited for use in connection with certain
14 projects or areas. Other agencies of the Government are
15 authorized to loan, without reimbursement, and the Founda-
16 tion is authorized to receive, such property and personnel as
17 may be deemed useful, with the approval of the Director of
18 the Bureau of the Budget. In addition to the authority con-
19 tained herein, the National Science Foundation, for the pur-
20 poses of this Act, may utilize any of the powers granted by
21 the National Science Foundation Act of 1950 (42 U. S. C.
22 1861–75).

23 SEC. 3. The Advisory Committee on Weather Control is
24 abolished effective December 31, 1957, and its functions,
25 duties, and records and any unexpended funds are transferred

to the National Science Foundation and there is authorized to be appropriated to the National Science Foundation, such amounts as are necessary to carry out the purposes of this Act.

Passed the Senate August 5 (legislative day, July 8), 1957.

Attest: FELTON M. JOHNSTON,

Secretary.

85TH CONGRESS
1ST SESSION

S. 86

AN ACT

To provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

AUGUST 6, 1957

Referred to the Committee on Interstate and Foreign Commerce

Digest of CONGRESSIONAL PROCEEDINGS
OF INTEREST TO THE DEPARTMENT OF AGRICULTURE

OFFICE OF BUDGET AND FINANCE
(For Department Staff Only)

Issued March 28, 1958
For actions of March 27, 1958
85th-2d, No. 50

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HIGHLIGHTS: Senate passed road authorization bill. Senate majority policy committee urges President to sign measure to freeze price supports and acreage allotments. House passed: Independent offices appropriation bill. Labor-HEW appropriation bill. House agreed to conference report to permit soil bank payments to certain producers who exceeded corn acreage allotments.

HOUSE

1. APPROPRIATIONS. Passed without amendment H. R. 11574, the independent offices appropriations bill for 1959 (pp. 4989-95). Rejected, 49 to 85, an amendment by Rep. Ostertag to increase the GSA general supply fund by $15 million (pp. 4989-90). Rejected an amendment by Rep. Porter to earmark $40 million of the National Science Foundation appropriation for basic research in colleges (pp. 4994-5).

Passed with amendment H. R. 11645, the Labor and Health, Education, and Welfare Departments appropriation bill for 1959 (pp. 4995-5019). The bill was amended by deleting three sections on which points of order were sustained, including a proposed requirement that the U. S. be reimbursed for expenses under the Mexican farm labor program (pp. 5018-19). Rep. Sullivan recommended a larger amount for the Food and Drug Administration (pp. 5004-7). Rep. Laird criticized the Budget Bureau and certain budgetary actions (pp. 5008-9). Rep. Marshall criticized the reduction in Labor apprenticeship and training programs, especially as "The present policy of the Department of Agriculture seems to be to improve the per capita income position of farmers by encouraging them to take advantage of non-farm income," and trained workers are preferred (p. 5016).

 House - March 27, 195

Agreed to allow the Appropriations Committee until midnight Fri., Mar. 28, to report the agricultural appropriation bill. p. 4988

Agreed to allow the Appropriations Committee until midnight Fri., Mar. 28, to report a joint resolution providing for advance procurement of supplies and equipment by Government agencies, to accelerate Federal expenditure programs. p. 4995

2. CORN. Adopted the conference report, as agreed to by the Senate, on H. R. 10843, to permit soil bank payments to certain corn producers in the commercial area who exceeded their corn acreage allotments. This bill will now be sent to the President. p. 4989

3. WEATHER CONTROL. The Interstate and Foreign Commerce Committee ordered reported with amendment S. 86, to authorize research in cloud modification. p. D269

4. EASTER RECESS. Both Houses adopted without amendment H. Con. Res. 303, to provide for an adjournment of both Houses from April 3 to April 14. pp. 4988, 4934

SENATE

5. ROADS. Passed, 84 to 4, with amendments H. R. 9821, the road authorization bill after substituting the language of similar bill S. 3414, as amended. S. 3414 was indefinitely postponed. pp. 4935, 4939-41, 4949-72

Rejected an amendment by Sen. Mansfield which would have authorized the waiving of all matching requirements for Federal funds allocated under the Federal Highway Act for a period of 1 year, with a $15 million maximum on primary and secondary systems, a $20 million maximum on the Interstate System (pp. 4939-41); and an amendment by Sen. Case to strike out the provisions of the bill providing for a 70-30 matching formula (for the extra $4000 million for primary and secondary roads) in States with large areas of public lands (pp. 4965-68).

Agreed to an amendment by Sen. Case to require a certification by the States upon submission of plans for Interstate System projects that public hearings have been held in rural areas to enable persons whose property will be affected by the highways to express any objections to the proposed location of the highway. pp. 4941-50

Conferees were appointed on the bill. p. 4971

6. EMERGENCY FEED; BROOMCORN. Sen. Kerr inserted resolutions from the agriculture committee of the Okla. State Legislative Council objecting to this Department rechecking all applicants approved for emergency feed relief during 1956 and 1957 for the purpose of redetermining eligibility of the applicants, and favoring an increase in tariff on the importation of broomcorn. p. 4920

7. PRICE SUPPORTS. Sen. Humphrey inserted a letter and article urging the President to sign the resolution to freeze acreage allotments and price supports, and an article stating that this Department is preparing "to make heavier than normal purchase of dairy products between now and April 1, when new and lower price supports go into effect." pp. 4944-45

Sens. Thye and Proxmire inserted telegrams received opposing a reduction in the price supports for dairy products, and urging that the President sign the resolution which would freeze such price supports. pp. 4929, 4932

8. ATOMIC ENERGY. Sen. Anderson inserted the speech of Rep. Durham, chairman of the Jt. Atomic Energy Committee, "Current Problems in the Atomic Power Development," including a discussion of the civilian atomic-power program. pp. 4925-27

Digest of CONGRESSIONAL PROCEEDINGS
OF INTEREST TO THE DEPARTMENT OF AGRICULTURE

OFFICE OF BUDGET AND FINANCE
(For Department Staff Only)

Issued May 8, 1958
For actions of May 7, 1958
85th-2d, No. 72

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HIGHLIGHTS: House Rules Committee cleared bill to transfer certain functions under Packers and Stockyards Act to FTC. House passed bill to fix price support on extra long-staple cotton at 60 to 75 percent of parity. House committee reported bill to extend mutual security program. Rep. Bow urged rejection of quotas in wheat referendum.

HOUSE - May 7, 1958

1. PACKERS AND STOCKYARDS. The Rules Committee reported a resolution for consideration of H. R. 9020, to transfer certain functions under the Packers and Stockyards Act from this Department to the Federal Trade Commission. p. 7402

2. COTTON. Passed without amendment H. R. 11399, to authorize the Secretary to set the level of price support for extra long-staple cotton at between 60 to 75 percent of parity. p. 7389

3. MUTUAL SECURITY. The Foreign Affairs Committee reported without amendment H. R. 12181, to extend the mutual security program (H. Rept. 1696). p. 7402

4. WEATHER MODIFICATION. The Interstate and Foreign Commerce Committee reported with amendment S. 86, to provide for a research program in the field of weather modification to be conducted by the National Science Foundation (H. Rept. 1695). p. 7402

5. EXPORT-IMPORT BANK. The Rules Committee reported a resolution for consideration of H. R. 10459, to increase the lending authority of the Export-Import Bank of Washington. p. 7402

6. VIRGIN ISLANDS. The Interior and Insular Affairs Committee ordered reported H. R. 12226, to extend the charter of the Virgin Islands Corporation to June 30, 1969. p. D394

7. FORESTRY. The Interior and Insular Affairs Committee ordered reported H. R. 6198, to transfer approximately 6,000 acres of land from the Sequoia National Park to the Sequoia National Forest, Calif. p. D394

8. WHEAT QUOTAS. Rep. Bow urged all eligible farmers to vote in the wheat quota referendum to be held June 20, stating that "in my own district we have a growing spirit of rebellion against the wheat law," and that "last year 22.6 percent of the farmers eligible to vote placed marketing quotas in effect on all wheat farmers." He also inserted a newspaper editorial urging wheat farmers to vote in the referendum. p. 7401

9. ECONOMIC SITUATION. Rep. Reuss urged a program to raise incomes and lower prices, including direct production payments to family-sized farms, and inserted a newspaper article discussing the current income and price situation. pp. 7392-94

10. BEANS. Rep. Bentley discussed increased production and consumption of beans. p. 7390

11. RECIPROCAL TRADE. Rep. Baily urged greater congressional control over reciprocal trade agreements, and urged "legislation that would restore congressional control at the very minimum to the point of controlling the escape clause remedy." pp. 7399-7400

12. POSTAL RATES. The "Daily Digest" states that conferees continued to resolve differences on the postal rate and pay increase bill, and "announced that agreement had been reached on a preferential rate of 2 cents for handwritten Government post cards." p. D396

SENATE

13. FORESTRY. Passed as reported S. 3051, to provide alternatives of either private or Federal acquisition of the part of the Klamath Indian forest lands which must be sold under the Termination Act. pp. 7352-63

Sen. Neuberger inserted an article urging passage of the Klamath bill. p. 7335

Sen. Wiley inserted a letter from the Menominee Coordinating and Negotiating Committee urging full Federal reimbursement for the sums spent by the Menominees in preparing for the Termination Act to become effective and opposing any change in the Termination Act. pp. 7334-5

Sen. Javits inserted resolutions of two N. Y. County Boards urging that the last day of April be fixed as National Arbor Day. p. 7326

14. FOREIGN AID. Sen. Wiley submitted an amendment to S. 3318, to extend the Mutual Security Act, which would make certain authorizations permanent, including technical aid, with the Organization of American States, refugee relief, the U. N. children's fund, ocean freight relief shipment charges, and Battle Act expenses. p. 7331

Sen. Mansfield submitted an amendment to this bill, to transfer the functions of the International Cooperation Administration to the Department of State. pp. 7331-2

85TH CONGRESS } HOUSE OF REPRESENTATIVES { REPORT
2d Session } { No. 1695

STUDY, RESEARCH, AND EVALUATION IN THE FIELD OF WEATHER MODIFICATION

MAY 7, 1958.—Committed to the Committee of the Whole House on the State of the Union and ordered to be printed

Mr. RHODES of Pennsylvania, from the Committee on Interstate and Foreign Commerce, submitted the following

REPORT

[To accompany S. 86]

The Committee on Interstate and Foreign Commerce, to whom was referred the bill (S. 86) to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes, having considered the same, report favorably thereon with amendments and recommend that the bill as amended do pass.

The amendments are as follows:

Strike out all after the enacting clause and insert the following:

That subsection (a) of section 3 of the National Science Foundation Act of 1950, as amended, is amended by striking out "and" at the end of paragraph (7), by striking out the period at the end of paragraph (8) and inserting in lieu thereof a semicolon, and by adding after paragraph (8) the following new paragraph:

"(9) to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena, and to report annually to the President and the Congress thereon."

SEC. 2. The National Science Foundation Act of 1950, as amended, is amended by changing the designations of sections 14, 15, and 16 (and all references to such sections in any provision of law) to 15, 16, and 17, respectively, and by inserting after section 13 the following section:

"WEATHER MODIFICATION

"SEC. 14. (a) In carrying out the provisions of paragraph (9) of section 3 (a), the Foundation shall consult with meteorologists and scientists in private life and with agencies of Government interested in, or affected by, experimental research in the field of weather control.

"(b) Research programs to carry out the purposes of such paragraph (9), whether conducted by the Foundation or by other Government agencies or departments, may be accomplished through contracts with, or grants to, private or public institutions or agencies, including but not limited to cooperative programs with any State through such instrumentalities as may be designated by the governor of such State.

"(c) For the purposes of such paragraph (9), the Foundation is authorized to accept as a gift, money, material, or services: *Provided*, That notwithstanding section 11 (f), use of any such gift, if the donor so specifies, may be restricted or limited to certain projects or areas.

"(d) For the purposes of such paragraph (9), other agencies of the Government are authorized to loan to the Foundation without reimbursement, and the Foundation is authorized to accept and make use of, such property and personnel as may be deemed useful, with the approval of the Director of the Bureau of the Budget.

"(e) The Director of the Foundation, or any employee of the Foundation designated by him, may for the purpose of carrying out the provisions of such paragraph (9) hold such hearings and sit and act at such times and places and take such testimony as he shall deem advisable. The Director or any employee of the Foundation designated by him may administer oaths or affirmations to witnesses appearing before the Director or such employees.

"(f) (1) The Director of the Foundation may obtain by regulation, subpena, or otherwise such information in the form of testimony, books, records, or other writings, may require the keeping of and furnishing such reports and records, and may make such inspections of the books, records, and other writings and premises or property of, any person or persons as may be deemed necessary or appropriate by him to carry out the provisions of such paragraph (9), but this authority shall not be exercised if adequate and authoritative data are available from any Federal agency. In case of contumacy by, or refusal to obey a subpena served upon, any person referred to in this subsection, the district court of the United States for any district in which such person is found or resides or transacts business, upon application by the Director, shall have jurisdiction to issue an order requiring such person to appear and give testimony or to appear and produce documents, or both; and any failure to obey such order of the court may be punished by such court as a contempt thereof.

"(2) the production of a person's books, records, or other documentary evidence shall not be required at any place other than the place where such person usually keeps them, if, prior to the return date specified in the regulations, subpena, or other document issued with respect thereto, such person furnishes the Foundation with a true copy of such books, records, or other documentary evidence (certified by such person under oath to be a true and correct copy) or enters into a stipulation with the Director as to the information contained in such books, records, or other documentary evidence. Witnesses shall be paid the same fees and mileage that are paid witnesses in the courts of the United States.

"(3) Any person who willfully performs any act prohibited or willfully fails to perform any act required by the above provisions of this subsection, or any regulation issued thereunder, shall upon conviction be fined not more than $500.

"(4) Information contained in any statement, report, record, or other document furnished pursuant to this subsection shall be available for public inspection, except (A) information authorized or required by statute to be withheld, and (B) information classified in accordance with law to protect the national security. The foregoing sentence shall not be interpreted to authorize or require the publication, divulging, or disclosure of any information described in section 1905 of title 18 of the United States Code, except that the Director may disclose information described in such section 1905, furnished pursuant to this subsection, whenever he determines that the withholding thereof would be contrary to the purposes of this section and section 3 (a) (9) of this Act."

Amend the title of the bill to read:

> An Act to amend the National Science Foundation Act of 1950, to provide for a program of study, research, and evaluation in the field of weather modification

General Statement

This legislation, as amended by this committee, would add new provisions to the National Science Foundation Act of 1950 for the following purposes:

(1) To direct the Foundation to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have ex-

perienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena;

(2) To direct the Foundation to report annually to the President and the Congress on such program; and

(3) To grant to the Foundation the power and authority which it will need in order to carry out such program effectively.

Hearings were held March 18 and 19 by the Subcommittee on Health and Science of your committee, in which extensive testimony favoring the legislation was heard. No one appeared in opposition to the legislation. Reports from interested Government agencies were favorable.

The legislation would in practical effect continue and expand, under a permanent operating agency of Government, a research program conducted by the Advisory Committee on Weather Control under authority of Public Law 256, 83d Congress. (Public Law 256 is included in the appendix to this report.)

Letter from agencies in the executive branch approving the legislation also are included in the appendix.

BACKGROUND OF THE LEGISLATION

The Advisory Committee on Weather Control was established to study and evaluate various experiments indicating that man can modify clouds and cause precipitation by various means and under certain conditions.

That Committee was composed of 11 members: 5 appointed from private life by the President and 6 from interested Government agencies.

The Committee, which went out of existence December 31, 1957, recommended the enactment of S. 86 in its final report to the President.

The Advisory Committee, in evaluating studies and operations in mountainous regions of the west coast of the United States under selected conditions, reported that—

> the evidence indicates that cloud seeding has produced an average increase of 10 to 15 percent in the precipitation from seeded storms.

As for other regions, however, the Committee reported that—

> the same procedures and testing methods did not detect any change in the precipitation—

that could be attributed to cloud seeding. The report added:

> But the fact that no increase in precipitation was detected does not warrant the conclusion that there was no increase—the increase may have been too slight to measure by the statistical methods used. In these areas, analytical difficulties are multiplied by the complicated rainfall processes in contrast to the comparatively simple west coast rainfall process.

Later in the report, the Committee pointed out that—

> in the absence of any clear-cut statistical conclusions, a farmer in a Midwestern State is still faced with the question: Should he buy commercial cloud seeding services?

RESEARCH PROGRAM RECOMMENDED

To reach correct conclusions, scientifically controlled experiments are necessary. These must include not only basic research to perfect present techniques and develop new methods but also applied or actual field tests.

Dr. Alan T. Waterman, Director, National Science Foundation, outlined the problem in a statement presented to the subcommittee. In that statement, he said, in part:

> I am familiar with the problems involved, not only as Director of the National Science Foundation but also from having been a member of the Advisory Committee on Weather Control. From the evaluation activities of the Advisory Committee, evidence to date seems clearly to indicate that no large rain-producing effects will be achieved by present means without further basic research to acquire a much fuller understanding of the processes by which nature produces rain or snow. Ability to modify weather including control of precipitation, presupposes accurate knowledge of what would happen at a predetermined time if we did not attempt modification. The word "modify" means "change"—changing something that we know in advance would happen naturally. Clearly better understanding is also needed for accurate prediction.
>
> It is my view, both from the studies of the Committee and from consideration given to the subject in the Foundation, that by far the most important element toward effective progress in weather modification at this time lies in a planned program in support of research by competent scientists on the fundamental problems dealing with the precipitation process * * *.

In outlining a proposed program to carry out the responsibilities which would be given the Foundation by this legislation, Dr. Waterman stated:

> If S. 86 is enacted, the National Science Foundation intends to press, as a matter of priority, for further effective basic research in the general area of weather modification, particularly in the fields of cloud physics and meteorology. It will carry forward evaluation programs begun by the Advisory Committee on Weather Control, and to the extent that sufficient scientific knowledge is available, initiate and support such applied research or development work as may appear reasonably promising. In undertaking the applied research and development activities, the Foundation would welcome and expect the cooperation of other Government agencies, such as the Departments of Defense, Interior, and Agriculture, and the Weather Bureau. It is my understanding that under S. 86 the Foundation could transfer funds to such agencies for these purposes.

NEED FOR LEGISLATION

Provisions in the bill recommended by your committee would permit the National Science Foundation to make grants to, or contracts

with, public or private institutions or agencies, including cooperative programs with States. The Foundation would also be able to arrange with other governmental agencies for handling of the applied or field aspects of the program. Such field research would be supplementary to the basic research as determined by the National Science Foundation to be important to purposes of the act.

Presently, no Federal agency has specific legislative authority or funds to carry out a program of basic and applied research in the field of weather modification. In addition to the lack of legislation, certain areas of investigation and experimentation are of such magnitude and legal status as to make it difficult to be conducted by other than Federal Government operation. Thus, your committee recommends a research program that will yield scientifically verifiable answers to the many questions in the important field of weather modification.

COMMITTEE AMENDMENT

After reviewing the hearings and studying S. 86 as it passed the Senate, the committee decided to amend the bill so as to incorporate its provisions into the National Science Foundation Act of 1950, as amended. The amendment does not change the basic objectives of the legislation. It was felt, however, that in the interest of clarity and orderly procedure the legislation should be enacted so as to become part of the National Science Foundation Act.

The committee added hurricanes to the list of weather phenomena the Foundation would be authorized to study.

In a letter to your committee urging favorable action on S. 86, which is printed in the appendix to this report, Director Waterman of the Foundation made this recommendation:

> However, we would like to recommend that a section be added to S. 86 authorizing the National Science Foundation to require by subpena information necessary to carry out its provisions. An example of the kind of language which would be appropriate for this purpose is to be found in section 9 (d) of Public Law 256, 83d Congress 1st session, establishing the Advisory Committee on Weather Control.

Authority to obtain information is granted the Director of the Foundation in subsection (f) of the proposed new section 14 which the amended bill proposes to add to the National Science Foundation Act. Such subsection (f) is patterned on section 9 (d) of Public Law 256, 83d Congress, above referred to.

The committee found it advisable to delete section 3 of the bill as passed by the Senate, reading as follows:

> SEC. 3. The Advisory Committee on Weather Control is abolished effective December 31, 1957, and its functions, duties, and records and any unexpended funds are transferred to the National Science Foundation and there is authorized to be appropriated to the National Science Foundation, such amounts as are necessary to carry out the purposes of this Act.

The Senate passed the bill last August. Since that time the Advisory Committee on Weather Control has ceased to exist, it having been required by the Supplemental Appropriation Act, 1958 (which

was enacted August 28, 1957), to terminate its activities by December 31, 1957. There being no such Committee at this time, it is not feasible to attempt to transfer functions, duties, and records, unexpended balances from it to the Foundation. Actually, so far as the records are concerned, the Committee has been told that they are now in the possession of the Foundation. As for the functions and duties which the Foundation is to have, the bill as amended is believed to be adequate.

AVAILABILITY OF INFORMATION

The bill (S. 86) as passed by the Senate contains nothing specific with respect to confidential treatment of information obtained under this legislation by the Foundation.

However, it does provide for the transfer to the National Science Foundation of the functions and duties of the Advisory Committee on Weather Control, which was established by Public Law 256 of the 83d Congress. One provision contained in Public Law 256, 83d Congress, was as follows:

> (4) Information obtained under this Act which the Committee deems confidential for purposes of national security or other reasons or with reference to which a request for confidential treatment is made by the person or agency furnishing such information, shall not be published or disclosed unless the Committee determines that the withholding thereof is contrary to the purposes of this Act, and any member or employee of the Committee wilfully violating this provision shall, upon conviction, be fined not more than $5,000.

Presumably S. 86, as passed by the Senate, was intended to make this provision applicable to information obtained by the National Science Foundation under S. 86.

The committee has given considerable thought to the problem of what the bill should provide with respect to making public the information which the Foundation would obtain under this proposed legislation.

In general, the committee feels that all information furnished should be available for public inspection unless there is some good reason to the contrary. The paragraph above quoted, from Public Law 256, seems not to have been written with this object in mind. Its emphasis seems to the committee to be on keeping information secret rather than on disclosing it whenever reasonably possible. The committee is in full agreement with the need to keep information confidential if disclosure would conflict with national security. However, the provision permitting the agency to keep information confidential for "other reasons," which in practice might be any reason at all, no matter how insubstantial, would give far too much undefined and unlimited power to the agency. Furthermore, the committee does not think that the agency should be compelled to treat information as confidential, solely because the person who furnished it asks that it be so treated, if keeping it confidential would be contrary to the purposes of the legislation.

For the foregoing reasons the committee has not included the provision from Public Law 256, but in lieu thereof, has included subsection (f) (4) of the new section 14 which the committee substitute

proposes to put into the National Science Foundation Act. Subsection (f) (4) reads as follows:

> (4) Information contained in any statement, report, record, or other document furnished pursuant to this subsection shall be available for public inspection, except (A) information authorized or required by statute to be withheld, and (B) information classified in accordance with law to protect the national security. The foregoing sentence shall not be interpreted to authorize or require the publication, divulging, or disclosure of any information described in section 1905 of title 18 of the United States Code, except that the Director may disclose information described in such section 1905, furnished pursuant to this subsection, whenever he determines that the withholding thereof would be contrary to the purposes of this section and section 3 (a) (9) of this Act.

This paragraph states the general rule that information furnished to the Foundation under the provisions of this legislation shall be available for public inspection. However, exceptions are made in clauses (A) and (B) of the first sentence—and these exceptions are discussed below;

By virtue of clause (A), information will not be required to be available for public inspection if it is "authorized or required by statute to be withheld." Section 1905 of title 18 of the United States Code is one statutory provision (and probably the principal one) which might "authorize or require" such information to be withheld. This will depend on the character of the information. The text of section 1905 is as follows:

> **§ 1905. Disclosure of confidential information generally**
>
> Whoever, being an officer or employee of the United States or of any department or agency thereof, publishes, divulges, discloses, or makes known *in any manner or to any extent not authorized by law* any information coming to him in the course of his employment or official duties or by reason of any examination or investigation made by, or return, report or record made to or filed with, such department or agency or officer or employee thereof, which information concerns or relates to the trade secrets, processes, operations, style of work, or apparatus, or to the identity, confidential statistical data, amount or source of any income, profits, losses, or expenditures of any person, firm, partnership, corporation, or association; or permits any income return or copy thereof or any book containing any abstract or particulars thereof to be seen or examined by any person except as provided by law; shall be fined not more than $1,000, or imprisoned not more than one year, or both; and shall be removed from office or employment. [Emphasis supplied.]

The proposed subsection (f) (4) contains a second sentence which reads in part as follows:

> The foregoing sentence shall not be interpreted to authorize or require the publication, divulging, or disclosure of any

> information described in section 1905 of title 18 of the United States Code. * * *

This language is included because of the clause shown in italic type in section 1905, as quoted above. The sole purpose of this language is to make it clear that the first sentence of the proposed subsection (f) (4) is not intended to give the kind of authorization referred to in the language of section 1905 so italicized.

Thus, with respect to information furnished to the National Science Foundation under this proposed legislation, section 1905 will in practical effect (with a single exception, explained below) forbid the publication, divulging, or disclosure thereof if it——

> concerns or relates to the trade secrets, processes, operations, style of work, or apparatus, or to the identity, confidential statistical data, amount or source of any income, profits, losses, or expenditures, of any person, firm, partnership, corporation, or association. * * *

In the preceding paragraph reference is made to an exception to the operation of section 1905 of title 18. This is contained in the second sentence of the proposed paragraph (4), in that part which provides that—

> * * * the Director may disclose any information described in such section 1905, and furnished pursuant to this subsection, whenever he determines that the withholding thereof would be contrary to the purposes of this section and section 3 (a) (9) of this Act.

The committee feels that this exception is necessary. Without it section 1905 of title 18 might be held to prevent disclosures of information when such disclosures are essential in order to successfully accomplish the objectives of this legislation.

The provision in Public Law 256 83d Congress, contained a penalty applicable to officers or employees publishing or disclosing information in violation of the provision. The committee is of the opinion that no criminal penalty is needed in case of the paragraph (4) put into the committee substitute. When a statute requires information to be withheld it may be expected to carry its own penalties, as section 1905 of title 18 does, if penalties are appropriate.

By virtue of clause (B) of the first sentence of the proposed paragraph (4), information furnished under this proposed legislation would not be required to be available for public inspection if it is "classified in accordance with law to protect the national security." This refers to information classified for security purposes under specific statutory authority (such as that contained in present sec. 15 of the National Science Foundation Act), or under the authority of Executive Order 10501, which is the order dealing generally with the authority of Federal departments and agencies to classify information for security purposes.

Paragraph (4) shall not authorize the withholding of information from any regularly constituted committee of the Senate or House of Representatives, or joint committee of the two Houses.

It is important to have the widest possible dissemination of information on weather modification, both to the public and to scientists working in this field, although it is realized that it may be necessary

in some instances to withhold certain information from public disclosure. The committee feels, however, that any person who makes information available under the new section 14 which the bill proposes to add to the National Science Foundation Act should have the privilege of filing with the Director written objection to making the information available for public inspection, stating the ground for such objection. In such a case the Director should determine whether the objection is well founded. If he finds that the objection is well founded and that the information should be withheld from public inspection, he should render a decision to that effect, citing the statutory authority for his determination, and, in addition, he should make his decision available for public inspection.

CHANGES IN EXISTING LAW

As passed by the Senate and referred to this committee, S. 86 would make no changes in existing law.

For the information of the House, certain provisions of the National Science Foundation Act of 1950, as amended, are set forth below.

Changes which the committee amendment would make in that act are shown as follows (existing law proposed to be omitted is enclosed in black brackets, new matter is printed in italics, existing law in which no change is proposed is shown in roman):

National Science Foundation Act of 1950, as Amended

AN ACT, To promote the progress of science; to advance the national health, prosperity, and welfare; to secure the national defense; and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That this Act may be cited as the "National Science Foundation Act of 1950".

ESTABLISHMENT OF NATIONAL SCIENCE FOUNDATION

Sec. 2. There is hereby established in the executive branch of the Government an independent agency to be known as the National Science Foundation (hereinafter referred to as the "Foundation"). The Foundation shall consist of a National Science Board (hereinafter referred to as the "Board") and a Director.

FUNCTIONS OF THE FOUNDATION

Sec. 3. (a) The Foundation is authorized and directed—

(1) to develop and encourage the pursuit of a national policy for the promotion of basic research and education in the sciences;

(2) to initiate and support basic scientific research in the mathematical, physical, medical, biological, engineering, and other sciences, by making contracts or other arrangements (including grants, loans, and other forms of assistance) for the conduct of such basic scientific research and to appraise the impact of research upon industrial development and upon the general welfare;

(3) at the request of the Secretary of Defense, to initiate and support specific scientific research activities in connection with matters relating to the national defense by making contracts or

other arrangements (including grants, loans, and other forms of assistance) for the conduct of such scientific research;

(4) to award, as provided in section 10, scholarships and graduate fellowships in the mathematical, physical, medical, biological, engineering, and other sciences;

(5) to foster the interchange of scientific information among scientists in the United States and foreign countries;

(6) to evaluate scientific research programs undertaken by agencies of the Federal Government, and to correlate the Foundation's scientific research programs with those undertaken by individuals and by public and private research groups;

(7) to establish such special commissions as the Board may from time to time deem necessary for the purposes of this Act; [and]

(8) to maintain a register of scientific and technical personnel and in other ways provide a central clearinghouse for information covering all scientific and technical personnel in the United States, includings its Territories and possessions [.];

(9) to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena, and to report annually to the President and the Congress thereon.

(b) In exercising the authority and discharging the functions referred to in subsection (a) of this section, it shall be one of the objectives of the Foundation to strengthen basic research and education in the sciences, including independent research by individuals, throughout the United States, including its Territories and possessions, and to avoid undue concentration of such research and education.

(c) The Foundation shall render an annual report to the President for submission on or before the 15th day of January of each year to the Congress, summarizing the activities of the Foundation and making such recommendations as it may deem appropriate. Such report shall include (1) minority views and recommendations if any, of members of the Board, and (2) information as to the acquisition and disposition by the Foundation of any patents and patent rights.

* * * * * * *

GENERAL AUTHORITY OF FOUNDATION

SEC. 11. The Foundation shall have the authority, within the limits of available appropriations, to do all things necessary to carry out the provisions of this Act, including, but without being limited thereto, the authority—

(a) to prescribe such rules and regulations as it deems necessary governing the manner of its operations and its organization and personnel;

(b) to make such expenditures as may be necessary for administering the provisions of this Act;

(c) to enter into contracts or other arrangements, or modifications thereof, for the carrying on, by organizations or individuals in the United States and foreign countries, including other government agencies of the United States and of foreign countries, of such basic scientific research activities as the Foundation deems

necessary to carry out the purposes of this Act, and, at the request of the Secretary of Defense, specific scientific research activities in connection with matters relating to the national defense, and, when deemed appropriate by the Foundation, such contracts or other arrangements, or modifications thereof, may be entered into without legal consideration, without performance or other bonds, and without regard to section 3709 of the Revised Statutes;

(d) to make advance, progress, and other payments which relate to scientific research without regard to the provisions of section 3648 of the Revised Statutes (31 U. S. C., sec. 529);

(e) to acquire by purchase, lease, loan, or gift, and to hold and dispose of by sale, lease, or loan, real and personal property of all kinds necessary for, or resulting from, the exercise of authority granted by this Act;

(f) to receive and use funds donated by others, if such funds are donated without restriction other than that they be used in furtherance of one or more of the general purposes of the Foundation;

(*g*) to publish or arrange for the publication of scientific and technical information so as to further the full dissemination of information of scientific value consistent with the national interest, without regard to the provisions of section 87 of the Act of January 12, 1895 (28 Stat. 622), and section 11 of the Act of March 1, 1919 (40 Stat. 1270; 44 U. S. C., sec. 111);

(h) to accept and utilize the services of voluntary and uncompensated personnel and to provide transportation and subsistence as authorized by section 5 of the Act of August 2, 1946 (5 U. S. C. 73b–2) for persons serving without compensation; and

(i) to prescribe, with the approval of the Comptroller General of the United States, the extent to which vouchers for funds expended under contracts for scientific research shall be subject to itemization or substantiation prior to payment, without regard to the limitations of other laws relating to the expenditure of public funds and accounting therefor.

* * * * * * *

(b) (1) The authority to enter into contracts or other arrangements with organizations or individuals in foreign countries and with agencies of foreign countries, as provided in section 11 (c), and the authority to cooperate in international scientific research activities as provided in subsection (a) of this section, shall be exercised only with the approval of the Secretary of State, to the end that such authority shall be exercised in such manner as is consistent with the foreign policy objectives of the United States.

(2) If, in the exercise of the authority referred to in paragraph (1) of this subsection, negotiation with foreign countries or agencies thereof becomes necessary, such negotiation shall be carried on by the Secretary of State in consultation with the Director.

WEATHER MODIFICATION

Sec. 14. (a) In carrying out the provisions of paragraph (9) of section 3 (a), the Foundation shall consult with meteorologists and scientists in private life and with agencies of Government interested in, or affected by, experimental research in the field of weather control.

(b) Research programs to carry out the purposes of such paragraph (9), whether conducted by the Foundation or by other Government agencies or departments, may be accomplished through contracts with, or grants to, private or public institutions or agencies, including but not limited to cooperative programs with any State through such instrumentalities as may be designated by the governor of such State.

(c) For the purposes of such paragraph (9), the Foundation is authorized to accept as a gift, money, material, or services: Provided, That notwithstanding section 11 (f), use of any such gift, if the donor so specifies, may be restricted or limited to certain projects or areas.

(d) For the purposes of such paragraph (9), other agencies of the Government are authorized to loan to the Foundation without reimbursement, and the Foundation is authorized to accept and make use of, such property and personnel as may be deemed useful, with the approval of the Director of the Bureau of the Budget.

(e) The Director of the Foundation, or any employee of the Foundation designated by him, may for the purpose of carrying out the provisions of such paragraph (9) hold such hearings and sit and act at such times and places and take such testimony as he shall deem advisable. The Director or any employee of the Foundation designated by him may administer oaths or affirmations to witnesses appearing before the Director or such employee.

(f) (1) The Director of the Foundation may obtain by regulation, subpena, or otherwise such information in the form of testimony, books, records, or other writings, may require the keeping of and furnishing such reports and records, and may make such inspections of the books, records, and other writings and premises or property of, any person or persons as may be deemed necessary or appropriate by him to carry out the provisions of such paragraph (9), but this authority shall not be exercised if adequate and authoritative data are available from any Federal agency. In case of contumacy by, or refusal to obey a subpena served upon, any person referred to in this subsection, the district court of the United States for any district in which such person is found or resides or transacts business, upon application by the Director, shall have jurisdiction to issue an order requiring such person to appear and give testimony or to appear and produce documents, or both; and any failure to obey such order of the court may be punished by such court as a contempt thereof.

(2) The production of a person's books, records, or other documentary evidence shall not be required at any place other than the place where such person usually keeps them, if, prior to the return date specified in the regulations, subpena, or other document issued with respect thereto, such person furnishes the Foundation with a true copy of such books, records, or other documentary evidence (certified by such person under oath to be a true and correct copy) or enters into a stipulation with the Director as to the information contained in such books, records, or other documentary evidence. Witnesses shall be paid the same fees and mileage that are paid witnesses in the courts of the United States.

(3) Any person who willfully performs any act prohibited or willfully fails to perform any act required by the above provisions of this subsection, or any regulation issued thereunder, shall upon conviction be fined not more than $500.

(4) Information contained in any statement, report, record, or other document furnished pursuant to this subsection shall be available for

public inspection, except (A) information authorized or required by statute to be withheld, and (B) information classified in accordance with law to protect the national security. The foregoing sentence shall not be interpreted to authorize or require the publication, divulging, or disclosure of any information described in section 1905 of title 18 of the United States Code, except that the Director may disclose information described in such section 1905, furnished pursuant to this subsection, whenever he determines that the withholding thereof would be contrary to the purposes of this section and section 3 (a) (9) of this Act.

MISCELLANEOUS PROVISIONS

SEC. [14] *15.* (a) The Director shall, in accordance with such policies as the Board shall from time to time prescribe, appoint and fix the compensation of such personnel as may be necessary to carry out the provisions of this Act. Such appointments shall be made and such compensation shall be fixed in accordance with the provisions of the civil-service laws and regulations and the Classification Act of 1949: *Provided*, That the Director may, in accordance with such policies as the Board shall from time to time prescribe, employ such technical and professional personnel and fix their compensation, without regard to such laws, as he may deem necessary for the discharge of the responsibilities of the Foundation under this Act. The Deputy Director hereinafter provided for, and the members of the divisional committees and special commissions, shall be appointed without regard to the civil-service laws or regulations. Neither the Director nor the Deputy Director shall engage in any other business, vocation, or employment than that of serving as such Director or Deputy Director, as the case may be; nor shall the Director or Deputy Director, except with the approval of the Board, hold any office in, or act in any capacity for, any organization, agency, or institution with which the Foundation makes any contract or other arrangement under this Act.

(b) The Director may appoint, with the approval of the Board, a Deputy Director who shall perform such functions as the Director, with the approval of the Board, may prescribe and shall be Acting Director during the absence or disability of the Director or in the event of a vacancy in the Office of the Director.

(c) The Foundation shall not, itself, operate any laboratories or pilot plants.

(*d*) The members of the Board, and the members of each divisional committee, or special commission, shall receive compensation at the rate of $25 for each day engaged in the business of the Foundation pursuant to authorization of the Foundation, and shall be allowed travel expenses as authorized by section 5 of the Act of August 2, 1946 (5 U. S. C. 73b–2).

(e) Persons holding other offices in the executive branch of the Federal Government may serve as members of the divisional committees and special commissions, but they shall not receive remuneration for their services as such members during any period for which they receive compensation for their services in such other offices.

(f) Service of an individual as a member of the Board, of a divisional committee, or of a special commission shall not be considered as service bringing him within the provisions of section 281, 283, or 284 of title 18 of the United States Code or section 190 of the

Revised Statutes (5 U. S. C. sec. 99), unless the act of such individual, which by such section is made unlawful when performed by an individual referred to in such section, is with respect to any particular matter which directly involves the Foundation or in which the Foundation is directly interested.

(g) In making contracts or other arrangements for scientific research, the Foundation shall utilize appropriations available therefor in such manner as will in its discretion best realize the objectives of (1) having the work performed by organizations, agencies, and institutions, or individuals in the United States or foreign countries, including Government agencies of the United States and of foreign countries, qualified by training and experience to achieve the results desired, (2) strengthening the research staff of organizations, particularly nonprofit organizations, in the States, Territories, possessions, and the District of Columbia, (3) aiding institutions, agencies, or organizations which, if aided, will advance basic research, and (4) encouraging independent basic research by individuals.

(h) Funds available to any department or agency of the Government for scientific or technical research, or the provision of facilities therefor, shall be available for transfer, with the approval of the head of the department or agency involved, in whole or in part, to the Foundation for such use as is consistent with the purposes for which such funds were provided, and funds so transferred shall be expendable by the Foundation for the purposes for which the transfer was made, and, until such time, as an appropriation is made available directly to the Foundation, for general administrative expenses of the Foundation without regard to limitations otherwise applicable to such funds.

(i) The National Roster of Scientific and Specialized Personnel shall be transferred from the United States Employment Service to the Foundation, together with such records and property as have been utilized or are available for use in the administration of such roster as may be determined by the President. The transfer provided for in this subsection shall take effect at such time or times as the President shall direct.

SECURITY PROVISIONS

SEC. [15] *16*. (a) The Foundation shall not support any research or development activity in the field of nuclear energy, nor shall it exercise any authority pursuant to section 11 (e) in respect to that field, without first having obtained the concurrence of the Atomic Energy Commission that such activity will not adversely affect the common defense and security. To the extent that such activity involves restricted data as defined in the Atomic Energy Act of 1946 the provisions of that Act regarding the control of the dissemination of restricted data and the security clearance of those individuals to be given access to restricted data shall be applicable. Nothing in this Act shall supersede or modify any provision of the Atomic Energy Act of 1946.

(b) (1) In the case of scientific or technical research activities under this Act in connection with matters relating to the national defense, with respect to which funds have been transferred to the Foundation from the Department of Defense in accordance with the provisions of section [14] *15* (h) of this Act, the Secretary of Defense shall establish

such security requirements and safeguards, including restrictions with respect to access to information and property, as he deems necessary.

(2) In the case of scientific research activities under this Act in connection with matters relating to the national defense other than research activities referred to in paragraph (1) of this subsection, the Foundation shall establish such security requirements and safeguards, including restrictions with respect to access to information and property, as it deems necessary.

(3) Any agency of the Government exercising investigatory functions is hereby authorized to make such investigations and reports as may be requested by the Foundation in connection with the enforcement of security requirements and safeguards, including restrictions with respect to access to information and property, established under paragraph (1) or (2) of this subsection.

(c) No employee of the Foundation shall be permitted to have access to information or property with respect to which access restrictions have been established under subsection (b) (1) or (2) until the Federal Bureau of Investigation shall have made an investigation into the character, associations, and loyalty of such individual and shall have reported the findings of said investigation to the Foundation, and the Foundation shall have determined that permitting such individual to have access to such information or property will not endanger the common defense and security.

(d) No part of any funds appropriated or otherwise made available for expenditure by the Foundation under authority of this Act shall be used to make payments under any scholarship or fellowship to any individual unless such individual (1) has executed and filed with the Foundation an affidavit that he does not believe in, and is not a member of and does not support any organization that believes in or teaches, the overthrow of the United States Government by force or violence or by any illegal or unconstitutional methods, and (2) has taken and subscribed to an oath or affirmation in the following form: "I do solemnly swear (or affirm) that I will bear true faith and allegiance to the United States of America and will support and defend the Constitution and laws of the United States against all its enemies, foreign and domestic.". The provisions of section 1001 of title 18, United States Code, shall be applicable with respect to such affidavits.

APPROPRIATIONS

SEC. [16] *17*. (a) To enable the Foundation to carry out its powers and duties, there is hereby authorized to be appropriated to the Foundation, out of any money in the Treasury not otherwise appropriated, such sums as may be necessary to carry out the provisions of this Act.

(b) Appropriations made pursuant to the authority provided in subsection (a) of this section shall remain available for obligation, for expenditure, or for obligation and expenditure, for such period or periods as may be specified in the Acts making such appropriations.

APPENDIX

Public Law 256, 83d Congress, as Amended

AN ACT To create a committee to study and evaluate public and private experiments in weather modification.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled,

STATEMENT OF PURPOSE AND POLICY

Research and experimentation in the field of weather modification and control have attained the stage at which the application of scientific advances in this field appears to be practical.

The effect of the use of measures for the control of weather phenomena upon the social, economic, and political structures of today, and upon national security, cannot now be determined. It is a field in which unknown factors are involved. It is reasonable to anticipate, however, that modification and control of weather, if effective on a large scale, would cause profound changes in our present way of life and would result in vast and far-reaching benefits to agriculture, industry, commerce, and the general welfare and common defense.

While the ultimate extent to which weather modification and control may be utilized is speculative, the application of such measures without proper safeguards, sufficient data and accurate information may result in inadequate or excessive precipitation; may cause catastrophic droughts, storms, floods, and other phenomena with consequent loss of life and property, injury to navigable streams and other channels of interstate and foreign commerce, injury to water supplies for municipal, irrigation, and industrial purposes, and injury to sources of hydroelectric power; may otherwise impede the production and transportation of goods and services for domestic consumption and export and for the national defense; and may otherwise adversely affect the general welfare and common defense

Thorough experimentation and full-scale operations in weather modification and control will of necessity affect areas extending across State and possibly across national boundaries. The Congress, therefore, recognizes that experimentation and application of such measures are matters of national and international concern.

Accordingly, it is hereby declared to be the policy of the Congress, in order to effect the maximum benefit which may result from experiments and operations designed to modify and control weather, to correlate and evaluate the information derived from such activity and to cooperate with the several States and the duly authorized officials thereof with respect to such activity, all to the end of encouraging the intelligent experimentation and the beneficial development of weather modification and control, preventing its harmful and indiscriminate exercise, and fostering sound economic conditions in the public interest.

CREATION OF ADVISORY COMMITTEE ON WEATHER CONTROL

SEC. 2. There is hereby established a national committee to be known as the Advisory Committee on Weather Control (hereinafter called the "Committee").

SEC. 3. The Committee shall make a complete study and evaluation of public and private experiments in weather control for the purpose of determining the extent to which the United States should experiment with, engage in, or regulate activities designed to control weather conditions.

SEC. 4. The Committee shall be composed of the Secretary of Defense or his designee, the Secretary of Agriculture or his designee, the Secretary of Commerce or his designee, the Secretary of the Interior or his designee, the Director of the National Science Foundation or his designee, the Secretary of Health Education, and Welfare or his designee, and five members appointed by the President, by and with the advice and consent of the Senate, from among persons in private life of outstanding ability in the fields of science, agriculture, and business. A vacancy in the Committee shall not affect its powers but shall be filled in the same manner that the original appointment was made.

SEC. 5. The President shall appoint the Chairman and Vice Chairman of the Committee. The Chairman shall be appointed from among those persons appointed to the Committee from private life.

SEC. 6. The Committee shall hold at least two meetings a year, approximately six months apart, and, on due notice, shall meet at such other times as the Committee may determine. Six members of the Committee shall constitute a quorum.

SEC. 7. The members of the Committee who are in the executive branch of the Government shall receive no additional compensation for their services on the Committee. The members from private life shall each receive $50 per diem when engaged in the performance of duties vested in the Committee. All members of the Committee shall be reimbursed in accordance with the Travel Expense Act of 1949, as amended, for travel, subsistence, and other necessary expenses incurred by them in the performance of duties vested in the Committee.

SEC. 8. The Committee shall have power to appoint and fix the compensation of such officers and employees as may be necessary to carry out the functions of the Committee, including one executive secretary at a salary not exceeding $12,000 per annum. Officers and employees other than the executive secretary shall be appointed in accordance with the Classification Act of 1949, as amended, except that to the extent the Committee deems such action necessary to the discharge of its responsibilities, personnel for positions requiring scientific or special qualifications may be employed and their compensation fixed without regard to such laws. The Committee shall make adequate provision for administrative review of any determination to dismiss any employee.

SEC. 9. (a) The Committee, or any member thereof, may, for the purpose of carrying out the provisions of this Act, hold such hearings and sit and act at such times and places, and take such testimony as the Committee shall deem advisable. Any member of the Committee may administer oaths or affirmations to witnesses appearing before the Committee or before such member.

(b) The Committee is authorized to secure directly from any executive department, bureau, agency, board, commission, office, independent establishment, or instrumentality information, suggestions, estimates, and statistics for the purpose of this Act; and each such department, bureau, agency, board, commission, office, establishment, or instrumentality is authorized and directed to furnish such information, suggestions, estimates, and statistics directly to the Committee, upon request made by the Chairman or Vice Chairman.

(c) The Committee may, with the consent of the agency concerned, accept and utilize, on a reimbursable basis, the personnel of any other agency of the Federal Government.

(d) (1) The Committee shall be entitled by regulation, subpena, or otherwise, to obtain such information from, require such reports and the keeping of such records by, and make such inspection of the books, records, and other writings, premises or property of, any person as may be necessary or appropriate to carry out the provisions of this Act, but this authority shall not be exercised if adequate and authoritative data are available from any Federal agency. In case of contumacy by, or refusal to obey a subpena served upon, any person referred to in this subsection, the district court of the United States for any district in which such person is found or resides or transacts business, upon application by the Committee, shall have jurisdiction to issue an order requiring such person to appear and give testimony or to appear and produce documents, or both; and any failure to obey such order of the court may be punished by such court as a contempt thereof.

(2) The production of a person's books, records, or other documentary evidence shall not be required at any place other than the place where such person usually keeps them, if, prior to the return date specified in the regulations, subpena, or other document issued with respect thereto, such person furnishes the Committee with a true copy of such books, records, or other documentary evidence (certified by such person under oath to be a true and correct copy) or enters into a stipulation with the Committee as to the information contained in such books, records, or other documentary evidence. Witnesses shall be paid the same fees and mileage that are piad witnesses in the courts of the United States.

(3) Any person who willfully performs any act prohibited or willfully fails to perform any act required by the above provisions of this subsection, or any rule, regulation, or order thereunder, shall upon conviction be fined not more than $500 for each offense.

(4) Information obtained under this Act which the Committee deems confidential for purposes of national security or other reasons or with reference to which a request for confidential treatment is made by the person or agency furnishing such information, shall not be published or disclosed unless the Committee determines that the withholding thereof is contrary to the purposes of this Act, and any member or employee of the Committee willfully violating this provision shall, upon conviction, be fined not more than $5,000.

(e) The Committee shall be entitled to the free use of the United States mails in the same manner as the other executive agencies of the Government.

SEC. 10. (a) The Committee shall from time to time submit a report on its findings and recommendations to the President for

submission to the Congress. At the earliest possible moment, the Committee shall submit a report to the President for submission to the Congress on the advisability of the Federal Government regulating, by means of licenses or otherwise, those who attempt to engage in activities designed to modify or control the weather. The Committee shall submit a final report to the President for submission to the Congress not later than June 30, 1958.

(b) Thirty days after the Committee has submitted such final report to the President, the Committee shall cease to exist.

SEC. 11. There are authorized to be appropriated, from any funds in the Treasury not otherwise appropriated, such sums as the Congress may from time to time deem necessary to carry out the provisions of this Act.

AGENCY REPORTS

The following letters from interested agencies were considered by the committee:

NATIONAL SCIENCE FOUNDATION,
OFFICE OF THE DIRECTOR,
Washington, D. C., March 17, 1958.

Hon. OREN HARRIS,
Congress of the United States,
House of Representatives, Washington, D. C.

MY DEAR MR. HARRIS: This is in reply to your letter of August 12, 1957, requesting the comments of the National Science Foundation with regard to S. 86, a bill to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

We are familiar with the problems involved not only because of the work of the National Science Foundation in supporting research in the field of meteorology but also through my membership on the Advisory Committee on Weather Control.

From the evaluation activities of the Advisory Committee, evidence to date seems clearly to indicate, except under certain very special conditions of topography, temperature and other favorable factors, that no large or important rain-producing effects will be achieved by present means without further research to acquire a better understanding of the process by which nature produces precipitation of rain or snow. It is my view, both from the studies of the Committee and from consideration given to the subject in the Foundation, that by far the most important element toward effective progress in weather modification at this time lies in a planned program in support of research by competent scientists on the fundamental problems dealing with the precipitation process. Such studies should be conducted under controlled laboratory conditions and also by carefully planned field experiments. The latter may consist of studies into the conditions under which precipitation occurs naturally and also of studies to determine the factors involved in the effects of man-made attempts to duplicate or augment natural processes. Plans for the latter type of field experiment should include authoritative means for statistical analysis and evaluation, a difficult task.

However, we would like to recommend that a section be added to S. 86 authorizing the National Science Foundation to require by

subpena information necessary to carry out its provisions. An example of the kind of language which would be appropriate for this purpose is to be found in section 9 (d) of Public Law 256, 83d Congress, 1st session, establishing the Advisory Committee on Weather Control.

It would seem unwise to attempt to embark upon any program having as its aim the development of a means of weather modification until we have some scientific assurance that such a means is practical and feasible. For these reasons, we advocate enactment of S. 86 which would specifically authorize a systematic reaserch program aimed at securing the answers we need in the general area of weather modification. The National Science Foundation intends to press for further effective research on this general subject. If S. 86 becomes law, the cooperation of other permanent agencies of the Federal Government would be actively sought in carrying out such plans for practical developments as might arise out of fundamental research.

The Bureau of the Budget has advised us that it has no objection to the submission of this report.

Sincerely yours,

ALAN T. WATERMAN, *Director.*

EXECUTIVE OFFICE OF THE PRESIDENT,
BUREAU OF THE BUDGET,
Washington, D. C., March 14, 1958.

Hon. OREN HARRIS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D. C.

MY DEAR MR. CHAIRMAN: This is in reply to your letters of August 12 and 16, 1957, requesting the views of this Office with respect to S. 86, as it passed the Senate August 6, 1957, and H. R. 9246, identical bills to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

These bills would authorize and direct the National Science Foundation to initiate and support a program of study, research, and evaluation in the field of weather modification.

In the reports that they are making to your committee, the National Science Foundation, and the Departments of Commerce, Agriculture, Interior, and Defense are recommending favorable action on S. 86 or H. R. 9246.

Although our view is that the National Science Foundation already possesses the necessary authority to carry out basic research needed to advance the field of weather modification, we would not object to enactment of these bills if the Congress believes that they would give a desirable emphasis to the Foundation's work on this subject.

It should be noted that the language in section 3 of the bills which abolishes the Advisory Committee on Weather Control is unnecessary in view of the passage of the Supplemental Appropriation Act, 1958, which provided that this Committee "shall complete its report and terminate its activities by December 31, 1957." These events have taken place. We understand, however, that the National Science Foundation would like to have the bills contain language transferring the records of the Committee to the Foundation.

Sincerely yours,

PERCIVAL F. BRUNDAGE, *Director.*

DEPARTMENT OF COMMERCE,
Washington, D. C., March 17, 1958.

Hon. OREN HARRIS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D. C.

DEAR MR. CHAIRMAN. This letter is in reply to your request of August 12, 1957, for the views of this Department with respect to S. 86, an act to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

S. 86 would authorize and direct the National Science Foundation to initiate and support a program of study, research, and evaluation of weather modification, and would abolish the Advisory Committee on Weather Control.

This Department recommends enactment of S. 86.

The Department believes that the extensive experimentation in cloud seeding which has been taken throughout the world has been inconclusive and indefinite. Progress in rainmaking, which potentially has the possibility of developing into a technically sound and respected field of meteorological engineering, has been retarded in recent years by a lack of coordination of the experimental activities carried on by public and private agencies. In addition, a major difficulty has been the limited number of research institutions qualified and equipped to carry out adequate programs of experiments in this field.

We believe that the program envisaged in S. 86, which would center responsibility for the planning and coordination of programs in this area in the National Science Foundation and which would authorize the Foundation to make arrangements for performance of research by qualified private and public institutions, will result in a more expeditious and economical approach to the development of weather modification techniques. The proposed program would also foster cooperation with private organizations and the States in the development of this meteorological phenomena.

For these reasons, the Department of Commerce recommends enactment of S. 86.

The Bureau of the Budget has advised that it would interpose no objection to the submission of this report to your committee.

Sincerely yours,

SINCLAIR WEEKS,
Secretary of Commerce.

DEPARTMENT OF THE INTERIOR,
OFFICE OF THE SECRETARY,
Washington, D. C., March 18, 1958.

Hon. OREN HARRIS,
Committee on Interstate and Foreign Commerce,
House of Representatives, Washington, D. C.

DEAR MR. HARRIS: This responds to your requests for the views of this Department on S. 86 and H. R. 9246, identical bills to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

We recommend the enactment of either bill.

These proposals would authorize the National Science Foundation to undertake and administer a research program in weather modification. The research program would be executed by making grants to, or contracts with, public or private institutions or agencies, as well as by arranging for cooperative programs with States. Provision is made for consultation with other interested Government agencies, and for the loan and utilization of personnel and property of other Government agencies, with the approval of the Director of the Bureau of the Budget. Annual reports would be required to be made to the President and to the Congress. Section 3 of the bills would abolish, as of December 31, 1957, the Advisory Committee on Weather Control, and transfer its functions, duties, records, and unexpended funds to the National Science Foundation.

In view of the various authorized natural resources programs for which the Department of the Interior is responsible, we have a definite interest in any work which affects water supplies and resources, and we would encourage the undertaking of any reasonable measures which will lead to the alleviation of water shortages, particularly in the arid States of the West, by bringing a supply of water where it is needed when it is needed. For these reasons, we have followed with more than a casual interest the experimental work being conducted in the weather-modification field.

It is our opinion that there is now a great need to obtain a better understanding of the basic physical principles involved in the precipitation process. If actual cloud-seeding operations are to be continued, we should know, in the first instance, the mechanism by which natural precipitation occurs and the manner in which cloud nucleation acts. We recognize that at an appropriate time there may be a need for well-controlled, large-scale cloud-seeding experiments to which the basic-research data could be applied.

Research of this kind involves long-term programing. For this reason, we favor placing general administrative responsibility in the National Science Foundation, which is devoted to administering various scientific-research programs and which has had substantial experience in working with educational institutions and other public and private research organizations.

The Bureau of the Budget has advised that there is no objection to the submission of this report to your Committee.

Sincerely yours,

FRED G. AANDAHL,
Assistant Secretary of the Interior.

DEPARTMENT OF AGRICULTURE,
Washington, D. C., March 18, 1958.

Hon. OREN HARRIS,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives.

DEAR CONGRESSMAN HARRIS: This is in reply to your requests of August 12 and 16, 1957, for reports on S. 86 and H. R. 9246, identical bills to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

The Department of Agriculture has no objection to the enactment of S. 86, as passed by the Senate or H. R. 9246 as introduced in the House.

The bills authorize the National Science Foundation to complete the evaluation work of the Advisory Committee on Weather Control and to undertake an orderly research program in weather modification. The bills would provide for the Foundation to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, or other weather phenomena. In conducting these studies, the Foundation would consult with meteorologists and scientists and with governmental agencies interested in, or affected by, experimental research in the field of weather control.

The availability of water for agricultural use is increasingly urgent, especially in those areas where population growth and growth of industry compete with agriculture for limited supplies. The thousands of forest fires started by lightning storms every year cause substantial damage to the Nation's forest resources. Basic information necessary to develop adequate means of weather modification is lacking. The National Science Foundation could, under the provisions of either bill, undertake the support of the basic research necessary for the development of the needed information.

The Bureau of the Budget advises that there is no objection to the submission of this report.

Sincerely yours,

E. T. Benson.

Department of the Air Force,
Office of the Secretary,
Washington, March 24, 1958.

Hon. Oren Harris,
Chairman, Committee on Interstate and Foreign Commerce,
House of Representatives.

Dear Mr. Chairman: Reference is made to your request for the comments of the Department of Defense on H. R. 9246, 85th Congress, a bill to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes. H. R. 9246 is identical to S. 86, which was passed by the Senate on August 5, 1957. The Secretary of Defense has delegated to this Department the responsibility for expressing the views of the Department of Defense on this legislative proposal.

The purpose of H. R. 9246 is to authorize and direct the National Science Foundation to support a research program in weather modification.

The Department of Defense favors enactment of H. R. 9246. The legislation provides a focal point within a governmental agency for research in the field of weather modification.

This report has been coordinated within the Department of Defense in accordance with procedures prescribed by the Secretary of Defense.

The Bureau of the Budget advises that there is no objection to the submission of this report.

Sincerely,

James H. Douglas.

DEPARTMENT OF COMMERCE,
Washington, March 27, 1958.

Hon. JOHN BELL WILLIAMS,
Chairman, Subcommittee on Health and Science,
Interstate and Foreign Commerce Committee,
House of Representatives, Washington, D. C.

DEAR MR. WILLIAMS: During hearings before your subcommittee March 19, on bill S. 86, to provide for an experimental research program in cloud modification a witness commented on the position of the Weather Bureau with respect to cloud-seeding experimentation. It is obvious that weather modification on a broad scale would have universal significance, economically, socially, and in practically all other aspects of life. I would like to make it clear that the Department of Commerce and the Weather Bureau strongly favor basic and applied research to bring out the possibilities and to ascertain the consequences of man-made weather "control."

Shortly after the first cloud-seeding experiments by Langmuir and Schaefer the Weather Bureau conducted extensive field tests along these lines in Alabama, California, and Ohio. The Ohio tests were made under systematic procedures, including radar control. These were the first such tests to be performed with reasonably adequate facilities for scientific analysis of the results of cloud seeding. They are still among the best documented ever conducted in this field. Results showed that the spectacular visual effects originally thought to be indications of greatly increased rainfall were largely optical effects and did not necessarily indicate increases in rainfall. These tests and subsequent research and field experiments by several recognized research institutions made evident that methods of weather modification so far developed are uncertain and relatively ineffective. The early suppositions that cloud seeding had caused widespread rainfall and recordbreaking floods or that seeding had diverted a hurricane were found to be without substantiation. Conclusions by the Weather Bureau and others stated that the most promising situations for increasing rainfall or snowfall by cloud seeding would be found in mountainous regions under conditions of supercooled droplets and certain other limitations. Little evidence was found of increased rainfall resulting from seeding in flatlands or in warm clouds and, in fact, some experimenters concluded that clouds dissolved by seeding might mean decrease in rainfall that would have resulted from natural causes. From these conclusions it was obvious that specific techniques would have to be designed to fit particular cases and that methods would have to be developed for determining the consequences before we could be sure that seeding would cause an increase, a decrease, or have no effect on rainfall in particular cases.

The Weather Bureau has constantly urged basic research to develop the possibilities of cloud seeding and other forms of weather modification, and has carried on studies and experiments to find better techniques for seeding and for evaluating the results with certainty. The broad extent of the Bureau's studies can be seen in the more than 75 technical papers published by Weather Bureau scientists on cloud seeding and related subjects since 1947. The Department of Commerce fully endorses this research program and favors the further research that would be authorized under the present provisions of bill S. 86.

Sincerely yours,

SINCLAIR WEEKS,
Secretary of Commerce.

○

Union Calendar No. 671

85TH CONGRESS
2D SESSION

S. 86

[Report No. 1695]

IN THE HOUSE OF REPRESENTATIVES

AUGUST 6, 1957

Referred to the Committee on Interstate and Foreign Commerce

MAY 7, 1958

Reported with amendments, committed to the Committee of the Whole House on the State of the Union, and ordered to be printed

[Strike out all after the enacting clause and insert the part printed in italic]

AN ACT

To provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

1 *Be it enacted by the Senate and House of Representa-*
2 *tives of the United States of America in Congress assembled,*
3 ~~The National Science Foundation is authorized and di-~~
4 ~~rected to initiate and support a program of study, research,~~
5 ~~and evaluation in the field of weather modification, giving~~
6 ~~particular attention to areas that have experienced floods,~~
7 ~~drought, hail, lightning, fog, tornadoes, or other weather~~
8 ~~phenomena, and to report annually to the President and the~~
9 ~~Congress thereon. In conducting such studies, the Founda-~~
10 ~~tion shall consult with meteorologists and scientists in private~~

1 ~~life and with agencies of Government interested in, or affected~~
2 ~~by, experimental research in the field of weather control. Re-~~
3 ~~search programs to carry out the purposes of this Act by~~
4 ~~the National Science Foundation, and by other Government~~
5 ~~agencies or departments, may be accomplished through con-~~
6 ~~tract with, or grants to, private or public institutions or agen-~~
7 ~~cies, including but not limited to cooperative programs with~~
8 ~~any State through such instrumentalities as may be desig-~~
9 ~~nated by the governor of such State.~~

10 ~~SEC. 2. For the purposes of this Act, the Foundation is~~
11 ~~authorized to accept as a gift, money, material, or services:~~
12 ~~*Provided*, That any such gift may, if the donor so specifies,~~
13 ~~be restricted or limited for use in connection with certain~~
14 ~~projects or areas. Other agencies of the Government are~~
15 ~~authorized to loan, without reimbursement, and the Founda-~~
16 ~~tion is authorized to receive, such property, and personnel as~~
17 ~~may be deemed useful, with the approval of the Director of~~
18 ~~the Bureau of the Budget. In addition to the authority con-~~
19 ~~tained herein, the National Science Foundation, for the pur-~~
20 ~~poses of this Act, may utilize any of the powers granted by~~
21 ~~the National Science Foundation Act of 1950 (42 U. S. C.~~
22 ~~1861–75).~~

23 ~~SEC. 3. The Advisory Committee on Weather Control is~~
24 ~~abolished effective December 31, 1957, and its functions,~~
25 ~~duties and records and any unexpended funds are transferred~~

~~to the National Science Foundation and there is authorized to be appropriated to the National Science Foundation, such amounts as are necessary to carry out the purposes of this Act.~~

That subsection (a) of section 3 of the National Science Foundation Act of 1950, as amended, is amended by striking out "and" at the end of paragraph (7), by striking out the period at the end of paragraph (8) and inserting in lieu thereof a semicolon, and by adding after paragraph (8) the following new paragraph:

"(9) to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena, and to report annually to the President and the Congress thereon."

SEC. 2. The National Science Foundation Act of 1950, as amended, is amended by changing the designations of sections 14, 15, and 16 (and all reference to such sections in any provision of law) to 15, 16, and 17, respectively, and by inserting after section 13 the following section:

"WEATHER MODIFICATION

"SEC. 14. (a) In carrying out the provisions of paragraph (9) of section 3 (a), the Foundation shall consult with meteorologists and scientists in private life and with

1 *agencies of Government interested in, or affected by, experi-*
2 *mental research in the field of weather control.*
3 *"(b) Research programs to carry out the purposes of*
4 *such paragraph (9), whether conducted by the Foundation*
5 *or by other Government agencies or departments, may be*
6 *accomplished through contracts with, or grants to, private*
7 *or public institutions or agencies, including but not limited*
8 *to cooperative programs with any State through such instru-*
9 *mentalities as may be designated by the governor of such*
10 *State.*
11 *"(c) For the purposes of such paragraph (9), the*
12 *Foundation is authorized to accept as a gift, money, material,*
13 *or services: Provided, That notwithstanding section 11 (f),*
14 *use of any such gift, if the donor so specifies, may be restricted*
15 *or limited to certain projects or areas.*
16 *"(d) For the purposes of such paragraph (9), other*
17 *agencies of the Government are authorized to loan to the*
18 *Foundation without reimbursement, and the Foundation is*
19 *authorized to accept and make use of, such property and*
20 *personnel as may be deemed useful, with the approval of*
21 *the Director of the Bureau of the Budget.*
22 *"(e) The Director of the Foundation, or any employee*
23 *of the Foundation designated by him, may for the purpose*
24 *of carrying out the provisions of such paragraph (9) hold*
25 *such hearings and sit and act at such times and places and*

1 *take such testimony as he shall deem advisable. The Director*
2 *or any employee of the Foundation designated by him may*
3 *administer oaths or affirmations to witnesses appearing before*
4 *the Director or such employee.*

5 *"(f) (1) The Director of the Foundation may obtain*
6 *by regulation, subpena, or otherwise such information in the*
7 *form of testimony, books, records, or other writings, may*
8 *require the keeping of and furnishing such reports and*
9 *records, and may make such inspections of the books, rec-*
10 *ords, and other writings and premises or property of any*
11 *person or persons as may be deemed necessary or appropriate*
12 *by him to carry out the provisions of such paragraph (9),*
13 *but this authority shall not be exercised if adequate and*
14 *authoritative data are available from any Federal agency.*
15 *In case of contumacy by, or refusal to obey a subpena served*
16 *upon, any person referred to in this subsection, the district*
17 *court of the United States for any district in which such*
18 *person is found or resides or transacts business, upon appli-*
19 *cation by the Director, shall have jurisdiction to issue an*
20 *order requiring such person to appear and give testimony*
21 *or to appear and produce documents, or both; and any failure*
22 *to obey such order of the court may be punished by such*
23 *court as a contempt thereof.*

24 *"(2) the production of a person's books, records, or*
25 *other documentary evidence shall not be required at any*

1 *place other than the place where such person usually keeps*
2 *them, if, prior to the return date specified in the regulations,*
3 *subpena, or other document issued with respect thereto, such*
4 *person furnishes the Foundation with a true copy of such*
5 *books, records, or other documentary evidence (certified by*
6 *such person under oath to be a true and correct copy) or*
7 *enters into a stipulation with the Director as to the informa-*
8 *tion contained in such books, records, or other documentary*
9 *evidence. Witnesses shall be paid the same fees and mileage*
10 *that are paid witnesses in the courts of the United States.*
11 *"(3) Any person who willfully performs any act pro-*
12 *hibited or willfully fails to perform any act required by the*
13 *above provisions of this subsection, or any regulation issued*
14 *thereunder, shall upon conviction be fined not more than*
15 *$500.*
16 *"(4) Information contained in any statement, report,*
17 *record, or other document furnished pursuant to this sub-*
18 *section shall be available for public inspection, except (A) in-*
19 *formation authorized or required by statute to be withheld*
20 *and (B) information classified in accordance with law to*
21 *protect the national security. The foregoing sentence shall*
22 *not be interpreted to authorize or require the publication,*
23 *divulging, or disclosure of any information described in sec-*
24 *tion 1905 of title 18 of the United States Code, except that*
25 *the Director may disclose information described in such sec-*

1 *tion 1905, furnished pursuant to this subsection, whenever*
2 *he determines that the withholding thereof would be contrary*
3 *to the purposes of this section and section 3 (a) (9) of this*
4 *Act.*"

Amend the title so as to read: "An Act to amend the National Science Foundation Act of 1950, to provide for a program of study, research, and evaluation in the field of weather modification."

Passed the Senate August 5 (legislative day, July 8), 1957.

Attest: FELTON M. JOHNSTON,
Secretary.

Union Calendar No. 671

85TH CONGRESS
2D SESSION

S. 86

[Report No. 1695]

AN ACT

To provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes.

AUGUST 6, 1957

Referred to the Committee on Interstate and Foreign Commerce

MAY 7, 1958

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Digest of CONGRESSIONAL PROCEEDINGS

OF INTEREST TO THE DEPARTMENT OF AGRICULTURE

OFFICE OF BUDGET AND FINANCE
(For Department Staff Only)

Issued June 20, 1958
For actions of June 19, 1958
85th-2d, No. 101

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HIGHLIGHTS: House committee reported omnibus farm bill. House committee ordered reported bill to authorize training for Federal employees at outside facilities.

HOUSE - June 19, 1958

1. FARM PROGRAM. The Agriculture Committee reported without amendment H. R. 12954, the omnibus farm bill. See Digest 99 for a summary of this bill. (H. Rept 1939). p. 10679
2. PERSONNEL. The Post Office and Civil Service Committee ordered reported with amendment S. 385, to authorize the training of Federal employees at public or private facilities. p. D567
3. WEATHER CONTROL. Passed as reported S. 86, to provide a weather modification research program under the direction of the National Science Foundation. pp. 10648-649, 10665-670
4. ROADS. The Public Works Committee reported without amendment H. R. 12776, to revise and codify title 23 of the U. S. Code, entitled "Highways" (H. Rept. 1938). p. 10679
5. MINERAL LEASES. The Interior and Insular Affairs Committee reported with amendment S. 2069, to amend the Mineral Leasing Act so as to promote the development of coal on the public domain (H. Rept. 1936). p. 10679

6. CHEMICAL ADDITIVES. The Interstate and Foreign Commerce Committee ordered reported without amendment H. R. 9521, to amend the Federal Food, Drug, and Cosmetic Act so as to revise the definition of the term "chemical additive" to provide that it shall not include any pesticide chemicals when used in or on any raw agricultural commodity which is produced from the soil. p. D567

7. APPROPRIATIONS. Passed with amendments, 361 to 18, H. R. 12858, making appropriations for civil functions administered by the Army, Interior, and TVA (includes appropriations for the Bureau of Reclamation, Bonneville Power Administration, Southeastern Power Administration and Southwestern Power Administration). pp. 10634-647

8. FOREIGN AID. Consent was granted until Friday night, June 20, for conferees to file a report on H. R. 12181, the mutual security authorization bill. p. 10673

9. WATERMELONS. Rep. Matthews expressed concern at the high retail price of watermelons, stating that they are retailing in D. C. at 5 cents a pound whereas the farmers in his district receive only one-fourth cent to one cent a pound. p. 10672

10. RESEARCH. Received from the National Science Foundation a proposed bill "to authorize the expenditure of funds through grants for support of scientific research and for other purposes"; to Interstate and Foreign Commerce Committee. p. 10679

11. LEGISLATIVE PROGRAM. Rep. McCormack announced that the conference report on H. R. 12181, the mutual security authorization bill, will be considered Tues., June 24, followed later in the week by H. R. 12954, the omnibus farm bill, if a rule is granted on it, and H. R. 4504, to improve marketing facilities for perishable commodities. p. 10654

12. ADJOURNED until Mon., June 23. p. 10679

SENATE

13. TAXATION. Continued debate on H. R. 12695, to extend for 1 year the corporate normal-tax rate and certain excise-tax rates. (pp. 10563-8, 10578-619). Agreed to, 59-25, an amendment by Sen. Smathers to repeal the transportation tax (pp. 10586-605).

14. FOREIGN AID. The Banking and Currency Committee ordered reported with amendment S. Res. 264, to establish an International Development Association in cooperation with the International Bank for Reconstruction and Development. p. D565

15. HOUSING. Sen. Sparkman reported for the Banking and Currency Committee an original bill without amendment S. 4035, the Housing Act of 1958. He stated that the bill would extend the program for farm housing research for 3 years, and authorize appropriations for each of the 3 years of $100,000. pp. 10621-624 (S. Rept. 1732).

Sen. Capehart submitted amendments he intends to propose to S. 4035, and a statement in explanation of the effects of the amendments. pp. 10625-631

16. FLOOD CONTROL. Conferees were appointed on S. 3910, the rivers and harbors and flood control authorization bill. House conferees have not yet been appointed. pp. 10571-578

the rehabilitation of foreign nations, it would be a national disgrace if the imperative and immediate needs of our New England and other flood ravaged regions, are not provided for with full Federal assistance before disaster strikes again.

Mr. BROOKS of Louisiana. Mr. Chairman, I ask unanimous consent to extend my remarks in the RECORD after the reading of title I.

The CHAIRMAN. Is there objection to the request of the gentleman from Louisiana?

There was no objection.

The Clerk concluded the reading of the bill.

Mr. CANNON. Mr. Chairman, I move that the Committee do now rise and report the bill back to the House with sundry amendments, with the recommendation that the amendments be agreed to and that the bill, as amended, do pass.

The motion was agreed to.

Accordingly the Committee rose; and the Speaker having resumed the chair, Mr. MILLS, Chairman of the Committee of the Whole House on the State of the Union, reported that that Committee, having had under consideration the bill (H. R. 12858) making appropriations for civil functions administered by the Department of the Army, certain agencies of the Department of the Interior and the Tennessee Valley Authority, for the fiscal year ending June 30, 1949, and for other purposes, had directed him to report the bill back to the House with sundry amendments, with the recommendation that the amendments be agreed to and that the bill, as amended, do pass.

Mr. CANNON. Mr. Speaker, I move the previous question on the bill and all amendments thereto to final passage.

The previous question was ordered.

The SPEAKER. Is a separate vote demanded on any amendment? If not, the Chair will put them en gross.

The amendments were agreed to.

The SPEAKER. The question is on the engrossment and third reading of the bill.

The bill was ordered to be engrossed and read a third time and was read the third time.

Mr. JONAS. Mr. Speaker, I offer a motion to recommit.

The SPEAKER. Is the gentleman opposed to the bill?

Mr. JONAS. I am, Mr. Speaker.

The SPEAKER. The Clerk will report the motion to recommit.

The Clerk read as follows:

Mr. JONAS moves to recommit the bill to the Committee on Appropriations.

Mr. CANNON. Mr. Speaker, I move the previous question on the motion to recommit.

The previous question was ordered.

The SPEAKER. The question is on the motion to recommit.

The motion to recommit was rejected.

The SPEAKER. The question is on the passage of the bill.

The question was taken; and on a division (demanded by Mr. TABER) there were—ayes 135, noes 10.

Mr. TABER. Mr. Speaker, I object to the vote on the ground that a quorum is not present and make the point of order that a quorum is not present.

The SPEAKER. Evidently a quorum is not present.

The Doorkeeper will close the doors, the Sergeant at Arms will notify absent Members, and the Clerk will call the roll.

The question was taken; and there were—yeas 361, nays 18, not voting 51, as follows:

[Roll No. 103]

YEAS—361

Abernethy
Adair
Addonizio
Albert
Alexander
Allen, Calif.
Allen, Ill.
Andersen, H. Carl
Anderson, Mont.
Andrews
Anfuso
Arends
Ashley
Ashmore
Aspinall
Auchincloss
Avery
Baker
Baldwin
Barden
Baring
Barrett
Bass, N. H.
Bass, Tenn.
Bates
Beamer
Becker
Beckworth
Belcher
Bennett, Fla.
Bennett, Mich.
Bentley
Berry
Betts
Blitch
Boland
Bolling
Bolton
Bonner
Bosch
Boykin
Boyle
Bray
Breeding
Brooks, La.
Brooks, Tex.
Broomfield
Brown, Ga.
Brown, Mo.
Brownson
Broyhill
Budge
Burleson
Bush
Byrd
Byrne, Ill.
Byrne, Pa.
Canfield
Cannon
Carnahan
Carrigg
Cederberg
Celler
Chamberlain
Chelf
Chenoweth
Chiperfield
Christopher
Church
Clark
Clevenger
Coad
Coffin
Cooley
Corbett
Coudert
Cramer
Cretella
Cunningham, Iowa
Cunningham, Nebr.
Curtin
Curtis, Mass.
Curtis, Mo.
Davis, Tenn.
Dawson, Ill.
Dawson, Utah
Delaney
Dellay
Dennison
Dent
Denton
Derounian
Devereux
Diggs
Dingell
Dixon
Dollinger
Donohue
Dooley
Dorn, N. Y.
Dorn, S. C.
Dowdy
Doyle
Durham
Dwyer
Elliott
Everett
Evins
Fallon
Farbstein
Fascell
Feighan
Fenton
Fino
Flood
Flynt
Forand
Ford
Forrester
Fountain
Frazier
Frelinghuysen
Fulton
Garmatz
Gary
Gathings
Gavin
George
Glenn
Gordon
Granahan
Grant
Gray
Green, Oreg.
Green, Pa.
Griffin
Griffiths
Gubser
Hagen
Hale
Haley
Halleck
Harden
Hardy
Harris
Harrison, Nebr.
Haskell
Hays, Ark.
Hays, Ohio
Healey
Hemphill
Henderson
Herlong
Heselton
Hess
Hiestand
Hill
Hillings
Hoeven
Holifield
Holland
Holmes
Holt
Holtzman
Horan
Hosmer
Huddleston
Hull
Hyde
Ikard
Jackson
Jarman
Jennings
Jensen
Johansen
Johnson
Jones, Ala.
Jones, Mo.
Karsten
Kean
Kearns
Keating
Kee
Kelly, N. Y.
Keogh
Kilburn
Kilgore
King
Kirwan
Kitchin
Kluczynski
Knox
Knutson
Lafore
Lane
Lankford
LeCompte
Lennon
Lesinski
Libonati
Lipscomb
Loser
McCormack
McCulloch
McDonough
McFall
McGovern
McGregor
McIntire
McIntosh
McMillan
McVey
Macdonald
Machrowicz
Mack, Ill.
Mack, Wash.
Madden
Magnuson
Mahon
Maillliard
Marshall
Martin
Matthews
May
Meader
Merrow
Metcalf
Michel
Miller, Calif.
Miller, Md.
Miller, Nebr.
Miller, N. Y.
Mills
Minshall
Mitchell
Montoya
Moore
Morano
Morgan
Morrison
Moss
Multer
Murray
Natcher
Nicholson
Nimtz
Nix
Norblad
Norrell
O'Brien, Ill.
O'Hara, Ill.
O'Hara, Minn.
O'Konski
O'Neill
Osmers
Ostertag
Passman
Patman
Patterson
Pelly
Perkins
Pfost
Philbin
Pilcher
Pillion
Poage
Polk
Porter
Powell
Price
Prouty
Quie
Rabaut
Ray
Reed
Reuss
Rhodes, Ariz.
Rhodes, Pa.
Riehlman
Riley
Roberts
Robeson, Va.
Robison, N. Y.
Robsion, Ky.
Rodino
Rogers, Colo.
Rogers, Fla.
Rogers, Mass.
Rogers, Tex.
Rooney
Roosevelt
Rutherford
Santangelo
St. George
Saund
Schenck
Schwengel
Scott, N. C.
Scott, Pa.
Scrivner
Scudder
Seeley-Brown
Selden
Sheehan
Shelley
Sheppard
Sikes
Siler
Simpson, Ill.
Simpson, Pa.
Smith, Calif.
Smith, Kans.
Smith, Miss.
Smith, Va.
Spence
Springer
Staggers
Stauffer
Steed
Sullivan
Talle
Taylor
Teague, Calif.
Teague, Tex.
Teller
Thomas
Thompson, N. J.
Thompson, Tex.
Thomson, Wyo.
Thornberry
Tollefson
Trimble
Udall
Utt
Vanik
Van Pelt
Van Zandt
Vinson
Vorys
Vursell
Wainwright
Walter
Watts
Westland
Wharton
Whitener
Whitten
Widnall
Wier
Wigglesworth
Williams, Miss.
Willis
Wilson, Calif.
Wilson, Ind.
Winstead
Withrow
Wright
Young
Younger
Zablocki
Zelenko

NAYS—18

Abbitt
Alger
Brown, Ohio
Byrnes, Wis.
Collier
Dague
Gross
Gwinn
Harrison, Va.
Harvey
Jonas
Laird
Mason
Mumma
Poff
Rees, Kans.
Taber
Tewes

NOT VOTING—51

Ayres
Bailey
Baumhart
Blatnik
Boggs
Bow
Buckley
Burdick
Colmer
Davis, Ga.
Dies
Eberharter
Edmondson
Engle
Fisher
Fogarty
Friedel
Gregory
Hébert
Hoffman
James
Jenkins
Judd
Kearney
Kilday
Krueger
Landrum
Latham
McCarthy
Morris
Moulder
Neal
O'Brien, N. Y.
Preston
Radwan
Rains
Reece, Tenn.
Rivers
Sadlak
Saylor
Scherer
Shuford
Sieminski
Sisk
Thompson, La.
Tuck
Ullman
Weaver
Williams, N. Y.
Wolverton
Yates

So the bill was passed.

The Clerk announced the following pairs:

On this vote:

Mr. Weaver for, with Mr. Bow against.

Mr. Baumhart for, with Mr. Jenkins against.

Mr. Hébert for, with Mr. Kearney against.

Mr. Edmondson for, with Mr. Krueger against.

Mr. Colmer for, with Mr. Burdick against.

Mr. Friedel for, with Mr. Williams of New York, against.

Until further notice:

Mr. Engle with Mr. Hoffman.

Mr. Sisk with Mr. Latham.

Mr. McCarthy with Mr. Neal.

Mr. Ullman with Reece of Tennessee.

Mr. Yates with Mr. James.

Mr. Boggs with Mr. Judd.

Mr. Thompson of Louisiana with Mr. Dixon.

Mr. Fogarty with Mr. Sadlak.

Mr. Preston with Mr. Ayres.

Mr. Landrum with Mr. Scherer.

Mr. Moulder with Mr. Saylor.

Mr. Kilday with Mr. Wolverton.

Mr. DAGUE changed his vote from "yea" to "nay."

The result of the vote was announced as above recorded.

A motion to reconsider was laid on the table.

The doors were opened.

GENERAL LEAVE TO EXTEND REMARKS

Mr. CANNON. Mr. Speaker, I ask unanimous consent that all Members may have 5 legislative days within which to revise and extend their remarks on the bill just passed.

The SPEAKER. Is there objection?

There was no objection.

AMENDMENT TO THE ATOMIC ENERGY ACT OF 1954, AS AMENDED

Mr. TRIMBLE. Mr. Speaker, by direction of the Committee on Rules, I call up the resolution, House Resolution 596, and ask for its immediate consideration.

The Clerk read the resolution, as follows:

Resolved, That upon the adoption of this resolution it shall be in order to move that the House resolve itself into the Committee of the Whole House on the State of the Union for the consideration of the bill (H. R. 12716) to amend the Atomic Energy Act of 1954, as amended. After general debate, which shall be confined to the bill and continue not to exceed 2 hours, to be equally divided and controlled by the chairman and ranking minority member of the Joint Committee on Atomic Energy, the bill shall be read for amendment under the 5-minute rule. At the conclusion of the consideration of the bill for amendment, the committee shall rise and report the bill to the House with such amendments as may have been adopted, and the previous question shall be considered as ordered on the bill and amendments thereto to final passage without intervening motion except one motion to recommit.

Mr. TRIMBLE. Mr. Speaker, I yield 30 minutes to the gentleman from Illinois [Mr. ALLEN].

Pending that I yield myself such time as I may require.

Mr. Speaker, House Resolution 596 makes in order the consideration of H. R. 12716, to amend the Atomic Energy Act of 1954, as amended. The resolution provides for an open rule and 2 hours of general debate.

The bill would permit closer cooperation between the nations of the free world in peaceful uses of atomic energy. The bill requires that any nation with which we are to exchange information and material must be making a substantial and material contribution to mutual defense and security. It should be pointed out that to date only Great Britain can meet the standards set forth in the bill.

Subject to certain conditions, limitations and procedures, the President may authorize the Atomic Energy Commission or the Department of Defense, with the assistance of the other, to cooperate with another nation and to transfer by sale, lease or loan to the nation material including nonnuclear parts of weapons, military reactors and nuclear materials for use in military reactors or weapons.

Provision is made to permit the communication of restricted information concerning military applications of atomic energy and delivery systems for atomic weapons to an individual nation, or regional defense group such as NATO. In addition, the Commission with the assistance of the Department of Defense may exchange restricted data concerning atomic weapons and military reactors. The President may also, under the terms of the bill, authorize a Government agency other than the AEC or Department of Defense to give restricted data to another nation.

The conditions, limitations and procedures include a Presidential determination that such cooperation will not constitute a risk; that the cooperating nation is a military ally participating with the United States in an international arrangement to make substantial contribution to the mutual defense and security; that cooperation must be undertaken pursuant to an agreement entered into in accordance with the procedures specified in section 123 of the AEC Act of 1954, as amended, with the President's approval, and providing that the Congress does not pass a concurrent resolution of disapproval within 60 days after the proposed agreement is submitted to Congress.

I urge the adoption of House Resolution 596.

I reserve the remainder of my time, Mr. Speaker.

Mr. ALLEN of Illinois. Mr. Speaker, I yield such time as he may desire to the gentleman from Wisconsin [Mr. WITHROW].

(Mr. WITHROW asked and was granted permission to revise and extend his remarks.)

[Mr. WITHROW addressed the House. His remarks will appear hereafter in the Appendix.]

Mr. ALLEN of Illinois. Mr. Speaker, I have no further requests for time.

Mr. TRIMBLE. Mr. Speaker, I move the previous question.

The previous question was ordered.

The SPEAKER. The question is on the resolution.

The resolution was agreed to.

A motion to reconsider was laid on the table.

STUDY RESEARCH AND EVALUATION IN THE FIELD OF WEATHER MODIFICATIONS

Mr. BOLLING. Mr. Speaker, by direction of the Committee on Rules, I call up the resolution, House Resolution 590, and ask for its immediate consideration.

The Clerk read the resolution, as follows:

Resolved, That upon the adoption of this resolution it shall be in order to move that the House resolve itself into the Committee of the Whole House on the State of the Union for the consideration of the bill (S. 86) to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes. After general debate, which shall be confined to the bill, and shall continue not to exceed one hour, to be equally divided and controlled by the chairman and ranking minority member of the Committee on Interstate and Foreign Commerce, the bill shall be read for amendment under the 5-minute rule. It shall be in order to consider without the intervention of any point of order the substitute amendment recommended by the Committee on Interstate and Foreign Commerce now in the bill and such substitute for the purpose of amendment shall be considered under the 5-minute rule as an original bill. At the conclusion of such consideration the Committee shall rise and report the bill to the House with such amendments as may have been adopted, and any Member may demand a separate vote in the House on any of the amendments adopted in the Committee of the Whole to the bill or committee substitute. The previous question shall be considered as ordered on the bill and amendments thereto to final passage without intervening motion except one motion to recommit with or without instructions.

Mr. BOLLING. Mr. Speaker, I yield myself 30 minutes, and to the gentleman from Illinois [Mr. ALLEN], 30 minutes.

Mr. Speaker, House Resolution 590 makes in order the consideraiton of S. 86, a bill providing for study, research, and evaluation in the field of weather modification. The resolution provides for an open rule, 1 hour of general debate, and also provides that the committee substitute written in the bill will be considered, without the intervention of any point of order, as an original bill for the purposes of amendment.

The amendment does not change the basic objectives of the bill as passed by the Senate. It merely incorporates the provisions of the bill into the National Science Foundation Act of 1950.

The National Science Foundation is directed to initiate a program of study by scientists of the problems dealing with the precipitation process, giving particular attention to areas that have experienced flood, drought, hail, lightning, fog, tornadoes and hurricanes. It will actually be a continuation and expansion of the program conducted by the Advisory Committee on Weather Control which went out of existence on December 31, 1957.

The bill grants the Foundaiton the power and authority to carry out the program effectively by making grants to, or contracts with, public or private institutions or agencies, including cooperative programs with States. The Foundation is also authorized to make arrangements with other Government agencies for handling the applied or field aspects of the program.

Further, the bill makes clear that it will be the general rule that information furnished to the Foundation will be available for public inspection except under certain circumstances, that is, information authorized or required by statute to be withheld, and information classified in accordance with law to protect the national security. However, the committee thought it was extremely important to have the widest possible dissemination of information on weather modification, and, therefore, wrote into the bill the provision that the Director of the Foundation may disclose information whenever he determines that the withholding would be contrary to the purposes of the bill.

Mr. Speaker, I reserve the balance of my time.

Mr. ALLEN of Illinois. Mr. Speaker, I know of no objection to the rule.

I reserve the balance of my time.

Mr. BOLLING. Mr. Speaker, I move the previous question on the resolution.

The previous question was ordered.

The resolution was agreed to.

A motion to reconsider was laid on the table.

AMENDING THE ATOMIC ENERGY ACT OF 1954, AS AMENDED

Mr. DURHAM. Mr. Speaker, I move that the House resolve itself into the Committee of the Whole House on the State of the Union for the consideration of the bill H. R. 12716.

The motion was agreed to.

Accordingly, the House resolved itself into the Committee of the Whole House on the State of the Union for the consideration of the bill (H. R. 12716) to amend the Atomic Energy Act of 1954, as amended, with Mr. JONES of Alabama in the chair.

The Clerk read the title of the bill.

By unanimous consent the first reading of the bill was dispensed with.

The CHAIRMAN. Under the rule the gentleman from North Carolina [Mr. DURHAM] will be recognized for 1 hour, and the gentleman from Pennsylvania [Mr. VAN ZANDT] for 1 hour.

The gentleman from North Carolina is recognized.

Mr. DURHAM. Mr. Chairman, I yield myself 10 minutes.

Mr. Chairman, just to acquaint the Members of the House with some of the background surrounding the creation of this legislation, if you will recall last fall it was decided by the President to call a meeting of the NATO countries and to discuss the need for the defense of the free countries of Europe. That meeting was called in December. At that time, the President made mention of the need for this type of legislation.

The first measure that was recommended to us by the AEC, the State Department, and the Department of Defense went a good deal further than this pending bill goes. The committee has held extensive hearings, morning and afternoon. We have gone over it very, very carefully. It is very technical, and this bill to amend the Atomic Energy Act of 1954, as amended, would permit, subject to certain conditions and limitations and procedures greater exchange of military information and materiel with our allies.

Mr. Chairman, the House has before it today a bill of the utmost importance—H. R. 12716.

This is a bill to amend the Atomic Energy Act of 1954, as amended, to permit—subject to certain conditions, limitations, and procedures—greater exchange of military information and material with our allies.

The proposed legislation before you today is the result of 4 months of study and consideration within the Joint Committee on Atomic Energy. The joint committee reported it out favorably, without amendment, and without an opposing vote.

The Secretary of State, in testimony supporting this bill, described it as "indispensable both to our collective security policy and to our disarmament policy"—hearings, page 446. The Atomic Energy Commission, the Department of Defense, and the Central Intelligence Agency have joined with the State Department in strongly endorsing this proposed legislation. In addition, General Lauris Norstad, supreme commander of the Allied Powers in Europe, has pointed out the urgent need for certain amendments to the basic law which are contained in this bill.

The primary purpose of this bill is to permit greater exchange of military information and material among the nations of the free world to that extent that it will assist the free world in its mutual defense and conserve that extremely scarce and important asset—scientific talent.

I want to make it extremely clear at the outset that this bill does not permit nor authorize the transfer of nuclear weapons by the United States to any nation. American nuclear weapons will remain within the custody of the United States. The Atomic Energy Act of 1954, as it stands today, does not authorize the transfer of nuclear weapons to another nation. The proposed amendments to the law, before you today, will not change this.

H. R. 12716 would amend the basic law to permit, subject to certain conditions, limitations, and procedures greater exchange with our military allies of certain types of information and material. The material would include nonnuclear parts of weapons. It would also include reactors, suitable for military purposes and nuclear material for use in military reactors and weapons. The specific materials that would be authorized to be transferred are enumerated in the proposed new subsections 91c (1), (2), (3), and (4).

With regard to the additional information that could be transferred under the proposed amendments, it is divided into two separate and distinct categories: One is classified information of a nature to assist an individual nation or regional defense group, such as NATO, to improve its training and to prepare for mutual defense. This is set out in the proposed amendments to section 144b. The second, and completely different type, is classified information of a nature to assist an individual ally to improve its atomic weapon design, development, or fabrication capability. This latter type of information is, of course, far more sensitive and hence the joint committee has placed certain additional requirements in the law which must be met before a nation is eligible to receive it.

Certain statements have ben made to the effect that the proposed amendments, as contained in H. R. 12716, are designed for and are specifically limited to the greater exchange of information and material with Great Britain and that no other nation would be eligible to take part in this greater cooperation. While to a great extent this is correct, it is not completely accurate. With regard to certain areas of material and classified information, allied nations—other than Great Britain—would be eligible, providing specific conditions and safeguards are met. In other areas, involving transfer of material and classified information, only Great Britain today could meet the specific standards set. This is a matter which I wish to have clearly understood by all Members of the House and hence I want to take sufficient time to explain.

Let me review the specific material that could be transferred. If you will refer to section (1) of the bill pertaining to the addition of a new subsection 91c, at the top of page 2 of the bill, it specifies four types of material that may be transferred: No. 1 is nonnuclear parts of atomic weapons to improve a nation's state of training and operational readiness. This, of course, does not include the nuclear component—that part which makes it an atomic weapon.

No. 2 pertains to utilization facilities for military applications. The Atomic Energy Act, under section 11aa, by definition, specifically excludes atomic weapons from the term "utilization facility." What are involved here are reactors designed for military purposes, such as the type used in a nuclear submarine.

The next type of material involved under 91c (3) would be source, byproduct, or special nuclear material for research on, development of, production of, or use in utilization facilities for military applications. No. 3 thus would authorize the United States to make available to our allies nuclear material of a nature needed in connection with military reactors they would develop or receive from the United States. This amendment is necessary because the Atomic Energy Act, as it stands today under section 123, does not permit the transfer of any nuclear material for military purposes.

Each one of the first three types of material that might be transferred, as you can see, does not make it possible for the recipient nation to achieve an atomic weapon capability. Subject to certain conditions, limitations, and procedures, allied nations, in addition to Great Britain, individually, would be eligible to receive such material.

You will note, however, there is a fourth type of material coming under section 91c. Number (4) pertains to source, byproduct, or special nuclear material for research on, development of, or use in atomic weapons. This type of material is directly related to nuclear weapon capability. This is the material without which a nation does not have nuclear weapon capability. It is in subsection 91c (4), therefore, that the Joint Committee added two specific provisos which, in effect, limit transfer of this latter type of material to the one ally today that already has nuclear weapons of its own—Great Britain. The two provisos are, one, that the transfer of such material to that nation is necessary to improve its atomic weapon design, development, or fabrication capability; and two, that such nation has made substantial progress in the development of atomic weapons. These two provisos were added by the Joint Committee in order to assure that such transfer could not be made to enable additional nations to achieve atomic weapon capability. As you know, only three nations in the world today have this capability—the United States, Great Britain, and

Russia. It is not the intent of the proposed legislation to encourage a "fourth or fifth nation" to enter this group. So you may understand the high standard that must be met before a nation would be eligible to receive nuclear material for use in a weapon, I refer you to page 12, paragraph 5, of the committee report, which states:

With regard to the words "substantial progress" in the second proviso of subsection 91c (4) it is intended that the cooperating nation must have achieved considerably more than a mere theoretical knowledge of atomic-weapons design, or the testing of a limited number of atomic weapons. It is intended that the cooperating nation must have achieved a capability on its own of fabricating a variety of atomic weapons, and constructed and operated the necessary facilities, including weapons research and development laboratories, weapon-manufacturing facilities, a weapon-testing station, and trained personnel to operate each of these facilities. It is intended that full information shall be provided the Joint Committee as to the basis of any such determination.

Let us now look at the types of classified information that could be transferred or exchanged with other nations under the proposed amendments:

First, there is that type of information which has to do with the knowledge of how to actually design, develop, or fabricate a weapon. This is, of course, very sensitive information. I refer you to section 7 of H. R. 12716, beginning on line 21 of page 7 and continuing over to line 10 on page 8 of the bill.

Section 7 amends the Atomic Energy Act by adding two new subsections. Section 144c (1) specifically has to do with exchanging with other nations restricted data concerning atomic weapon design, development, and fabrication information. You will note, however, that basically the same two provisos would be contained in subsection 144c (1) as would exist in subsection 91c (4) previously mentioned—that such restricted data to that nation "is necessary to improve its atomic weapon design, development, or fabrication capability" and that nation "has made substantial progress in the development of atomic weapons." As previously explained with regard to subsection 91c (4) only Great Britain today can meet the standards required by those two provisos. The United States thus would not encourage or assist other nations to develop or possess nuclear weapons.

Subsection 144c (2) permits the exchange or communication with another nation of classified information concerning research, development, or design of military reactors, such as, for instance, to be used in a nuclear submarine. By interpretation, the present law permits exchange of this type of information and agreements have already been entered into with Canada and the United Kingdom for this purpose.

The second separate and distinct category of classified information that would be permitted to be transmitted to an ally is that type of information which will assist an individual nation or a regional defense group, such as NATO, to improve its training and to prepare for mutual defense. This kind of information is not of a type that will permit the recipient to manufacture its own weapons. It is information of a nature to permit our allies to properly prepare their defenses against enemy nuclear attack.

This category of information is treated separately under amendment to section 144b of the Atomic Energy Act and is covered in section 6 of the bill, beginning on page 6, line 12. The committee report, on page 43, reflects the specific changes which would be made in section 144b.

Section 144b, as it exists today, and as proposed in this bill, will permit communication of classified information to another nation or to a regional defense group as is necessary to the development of defense plans. There is no change in that item. It will also permit communication of classified information for the purpose of training personnel in the employment of and defense against atomic weapons as is permitted under the current law. The bill, however, will extend this type of information to include other military applications of atomic energy, as, for example, with regard to military-type reactors. Similarly, the existing law which permits communication of information necessary to the evaluation of the capability of potential enemies in the employment of atomic weapons, would be extended to include other military applications of atomic energy.

A new fourth area of information would be added to this list and that would be information necessary to the development of compatible delivery systems for atomic weapons. This would be information which will permit our allies to design their planes, missiles, and other carriers in such a manner that they will be compatible with our nuclear bombs and warheads and could immediately be utilized in the event of war. There is no sense in our allies producing planes or missiles for our mutual defense if these weapons systems cannot readily be utilized to deliver our modern weapons or would have to undergo time-consuming modifications when we could ill afford to lose such time.

A fifth area of information is also added to section 144b and that is information pertaining to other military applications of atomic energy specifically excluding, however, information which relates to development, design, or production of atomic weapons or military reactors. This fifth area might involve information, for instance, having to do with the military application of isotopes.

In addition to adding to the limited areas of information that may be transferred to an individual nation or regional defense organization under section 144b, the proposed bill eliminates certain restrictive language now contained in section 144b. If you will refer to the committee report, beginning on page 43, the last line and continuing through most of the first paragraph on page 44, you will observe the restrictive language of the present law which would be eliminated by the proposed legislation. This language has been interpreted by the Atomic Energy Commission very strictly and has resulted in information being withheld from our allies which would be most helpful to them in planning their defenses and which is already known by our common enemy. In this regard, while the committee is most gratified that the Commission in its responsibilities has been most strict in its interpretation of the law under this section, we believe that it is foolish for the United States to keep from our allies information which would be helpful to them and to ourselves in developing our mutual defense when such information is already known to our common enemy.

I have attempted to cover for you the specific types of material and information that this bill will permit the United States to transfer or communicate to our allies. I have attempted to designate those relatively sensitive areas relating to the knowledge or ability to produce atomic weapons and which as of today we would cooperate only with Great Britain under this bill. I have also attempted to cover those other areas of information and material which do not involve the knowledge or ability to design or fabricate weapons but which are neecssary for adequate defensive planning. These latter categories of material and information are needed for the proper preparation of defenses and could be transferred to allies other than Great Britain.

As I mentioned earlier, the proposed legislation would permit greater exchange of military information and material with our allies but the cooperation would be subject to certain specific conditions, limitations, and procedures which are contained in the recommended bill and explained in the accompanying report.

Appropriate safeguards are contained in the bill to assure such transfers or exchanges will promote the national defense and will not constitute undue risks to this country. They will be covered in detail by one of my colleagues from the Joint Committee.

In conclusion, I wish to refer your attention to pages 5, 6, and 7 of the committee report, which contains a list of the various Government agencies and representatives who testified in support of this proposed legislation. All of these Government witnesses, representing the executive agencies most concerned, strongly endorsed this bill. The Joint Committee has considered it most carefully for over 4 months and favorably reported it without a dissenting vote from any member.

Mr. VAN ZANDT. Mr. Chairman, I yield myself 15 minutes.

Mr. Chairman, I rise in support of H. R. 12716, a bill to amend the Atomic Energy Act of 1954, as amended. It was my privilege to introduce an identical bill, H. R. 12727, and I support this proposed legislation wholeheartedly.

My colleague, Congressman CARL DURHAM, the distinguished chairman of the Joint Committee, has already explained to you the provisions and purposes of this bill. In addition, at pages 1 and 2 of the Joint Committee report, my colleagues in the House can find a summary of the proposed legislation, including a summary of the conditions,

So the amendment was rejected.

The CHAIRMAN. Under the rule, the Committee rises.

Accordingly the Committee rose; and the Speaker having resumed the chair, Mr. JONES of Alabama, Chairman of the Committee of the Whole House on the State of the Union, reported that that Committee having had under consideration the bill (H. R. 12716) to amend the Atomic Energy Act of 1954, as amended, pursuant to House Resolution 596, he reported the bill back to the House.

The SPEAKER. Under the rule, the previous question is ordered.

The question is on the engrossment and third reading of the bill.

The bill was ordered to be engrossed and read a third time, and was read the third time.

The SPEAKER. The question is on the passage of the bill.

Mr. PATTERSON. Mr. Speaker, on that I demand the yeas and nays.

The yeas and nays were ordered.

The question was taken; and there were—yeas 345, nays 12, not voting 73, as follows:

[Roll No. 104]

YEAS—345

Abbitt
Adair
Addonizio
Albert
Alexander
Alger
Allen, Calif.
Allen, Ill.
Andersen, H. Carl
Anderson, Mont.
Andrews
Ashley
Ashmore
Aspinall
Auchincloss
Avery
Bailey
Baker
Baldwin
Barden
Baring
Barrett
Bass, N. H.
Bass, Tenn.
Bates
Beamer
Becker
Beckworth
Belcher
Bennett, Mich.
Bentley
Berry
Betts
Blatnik
Blitch
Boland
Bolling
Bolton
Bonner
Bosch
Boykin
Boyle
Bray
Breeding
Brooks, La.
Brooks, Tex.
Broomfield
Brown, Ga.
Brown, Mo.
Brown, Ohio
Brownson
Broyhill
Budge
Burdick
Burleson
Bush
Byrd
Byrne, Ill.
Byrne, Pa.
Byrnes, Wis.
Canfield
Cannon
Carnahan
Carrigg
Cederberg
Chamberlain
Chelf
Chenoweth
Chiperfield
Christopher
Church
Clark
Clevenger
Coad
Coffin
Collier
Cooley
Corbett
Cramer
Cretella
Cunningham, Iowa
Curtin
Curtis, Mass.
Curtis, Mo.
Dague
Davis, Tenn.
Dawson, Utah
Delaney
Dellay
Dennison
Denton
Derounian
Devereux
Diggs
Dingell
Dixon
Dollinger
Donohue
Dorn, N. Y.
Dorn, S. C.
Doyle
Durham
Dwyer
Elliott
Everett
Evins
Fallon
Farbstein
Fascell
Feighan
Fenton
Flood
Flynt
Forand
Ford
Forrester
Fountain
Frazier
Frelinghuysen
Fulton
Garmatz
Gary
Gathings
George
Granahan
Grant
Gray
Green, Pa.
Griffin
Griffiths
Gross
Gubser
Gwinn
Hagen
Hale
Haley
Halleck
Harden
Hardy
Harris
Harrison, Nebr.
Harrison, Va.
Harvey
Haskell
Hemphill
Henderson
Herlong
Heselton
Hess
Hiestand
Hill
Hillings
Hoeven
Hoffman
Holifield
Holland
Holmes
Holt
Holtzman
Horan
Hosmer
Huddleston
Hull
Hyde
Ikard
Jackson
Jarman
Jennings
Jensen
Johansen
Johnson
Jonas
Jones, Ala.
Jones, Mo.
Judd
Karsten
Kean
Kearns
Keating
Kee
Kelly, N. Y.
Kilburn
Kilgore
King
Kirwan
Kitchin
Kluczynski
Knutson
Lafore
Laird
Lane
Lankford
LeCompte
Lennon
Lesinski
Libonati
Lipscomb
Loser
McCormack
McCulloch
McDonough
McFall
McGovern
McGregor
McIntire
McIntosh
McMillan
McVey
Macdonald
Machrowicz
Mack, Ill.
Madden
Magnuson
Mahon
Mailliard
Marshall
Martin
Matthews
May
Meader
Merrow
Metcalf
Michel
Miller, Calif.
Miller, Md.
Miller, Nebr.
Miller, N. Y.
Mills
Minshall
Mitchell
Montoya
Moore
Morano
Morgan
Morrison
Moss
Mumma
Murray
Natcher
Nicholson
Nimtz
Nix
Norblad
Norrell
O'Brien, Ill.
O'Hara, Minn.
O'Konski
O'Neill
Osmers
Ostertag
Passman
Patman
Patterson
Pelly
Pfost
Philbin
Pilcher
Poage
Poff
Polk
Porter
Powell
Price
Prouty
Quie
Rabaut
Ray
Reed
Rees, Kans.
Reuss
Rhodes, Ariz.
Rhodes, Pa.
Riehlman
Riley
Roberts
Robeson, Va.
Robison, N. Y.
Robsion, Ky.
Rodino
Rogers, Colo.
Rogers, Fla.
Rogers, Mass.
Rogers, Tex.
Rooney
Roosevelt
Rutherford
Santangelo
St. George
Saund
Schenck
Scott, N. C.
Scott, Pa.
Scrivner
Scudder
Seely-Brown
Selden
Sheehan
Shelley
Sheppard
Sikes
Siler
Simpson, Ill.
Smith, Calif.
Smith, Kans.
Smith, Miss.
Smith, Va.
Spence
Springer
Staggers
Stauffer
Steed
Sullivan
Talle
Teague, Calif.
Tewes
Thomas
Thompson, N. J.
Thompson, Tex.
Thomson, Wyo.
Thornberry
Tollefson
Trimble
Udall
Utt
Vanik
Van Pelt
Van Zandt
Vorys
Vursell
Wainwright
Walter
Watts
Whitener
Widnall
Wier
Wigglesworth
Willis
Wilson, Calif.
Wilson, Ind.
Withrow
Wright
Young
Younger
Zablocki
Zelenko

NAYS—12

Abernethy
Bennett, Fla.
Cunningham, Nebr.
Dent
Dooley
Dowdy
Green, Oreg.
O'Hara, Ill.
Wharton
Whitten
Williams, Miss.
Winstead

NOT VOTING—73

Anfuso
Arends
Ayres
Baumhart
Boggs
Bow
Buckley
Celler
Colmer
Coudert
Davis, Ga.
Dawson, Ill.
Dies
Eberharter
Edmondson
Engle
Fino
Fisher
Fogarty
Friedel
Gavin
Glenn
Gordon
Gregory
Hays, Ark.
Hays, Ohio
Healey
Hébert
James
Jenkins
Kearney
Keogh
Kilday
Knox
Krueger
Landrum
Latham
McCarthy
Mack, Wash.
Mason
Morris
Moulder
Multer
Neal
O'Brien, N. Y.
Perkins
Pillion
Preston
Radwan
Rains
Reece, Tenn.
Rivers
Sadlak
Saylor
Scherer
Schwengel
Shuford
Sieminski
Simpson, Pa.
Sisk
Taber
Taylor
Teague, Tex.
Teller
Thompson, La.
Tuck
Ullman
Vinson
Weaver
Westland
Williams, N. Y.
Wolverton
Yates

So the bill was passed.

The Clerk announced the following pairs:

Mr. Hébert with Mr. Glenn.
Mr. Yates with Mr. Baumhart.
Mr. Ullman with Mr. Arends.
Mr. Moulder with Mr. Simpson of Pennsylvania.
Mr. McCarthy with Mr. Taber.
Mr. Engle with Mr. Wolverton.
Mr. Boggs with Mr. Fino.
Mr. Friedel with Mr. Gavin.
Mr. Fogarty with Mr. Coudert.
Mr. Colmer with Mr. Ayres.
Mr. Edmondson with Mr. Taylor.
Mr. Preston with Mr. Jenkins.
Mr. Landrum with Mr. Weaver.
Mr. Sisk with Mr. Neal.
Mr. Thompson of Louisiana with Mr. Latham.
Mr. Dawson of Illinois with Mr. Bow.
Mr. Hays of Ohio with Mr. Mason.
Mr. Hays of Arkansas with Mr. James.
Mr. Keogh with Mr. Sadlak.
Mr. Anfuso with Mr. Reece of Tennessee.
Mr. Healey with Mr. Radwan.
Mr. Celler with Mr. Mack of Washington.
Mr. Multer with Mr. Kearney.
Mr. Teller with Mr. Westland.
Mr. Teague of Texas with Mr. Knox.
Mr. Buckley with Mr. Pillion.
Mr. Gordon with Mr. Saylor.
Mr. Tuck with Mr. Scherer.
Mr. Kilday with Mr. Williams of New York.
Mr. O'Brien of New York with Mr. Krueger.
Mr. Morris with Mr. Schwengel.

The result of the vote was announced as above recorded.

A motion to reconsider was laid on the table.

MESSAGE FROM THE SENATE

A message from the Senate, by Mr. McGown, one of its clerks, announced that the Senate disagrees to the amendment of the House to the bill (S. 3910), entitled "An act authorizing the construction, repair, and preservation of certain public works on rivers and harbors for navigation, flood control, and for other purposes," agrees to the conference asked by the House on the disagreeing votes of the two Houses thereon, and appoints Mr. CHAVEZ, Mr. KERR, Mr. MCNAMARA, Mr. MARTIN of Pennsylvania, and Mr. CASE of South Dakota, to be the conferees on the part of the Senate.

The message also announced that the Senate disagrees to the amendments of the House to the bill (S. 1850) entitled "An act to adjust conditions of employment in departments or agencies in the Canal Zone," requests a conference with the House on the disagreeing votes of the two Houses thereon, and appoints Mr. JOHNSTON of South Carolina, Mr. NEUBERGER, and Mr. CARLSON to be the conferees on the part of the Senate.

The message also announced that the Vice President has appointed Mr. JOHNSTON of South Carolina and Mr. CARLSON members of the joint select committee on the part of the Senate, as provided for in the act of August 5, 1939, entitled "An act to provide for the disposition of certain records of the United States Government," for the disposition of executive papers referred to in the report of the Archivist of the United States numbered 58–16.

WEATHER MODIFICATION

Mr. HARRIS. Mr. Speaker, I ask unanimous consent for the immediate consideration of the bill (S. 86) to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes; and that it be considered in the House as in Committee of the Whole.

The Clerk read the title of the bill.

The SPEAKER. Is there objection to the request of the gentleman from Arkansas?

Mr. MARTIN. Mr. Speaker, reserving the right to object, the gentleman is going to explain the bill?

Mr. HARRIS. It is my purpose to do so.

Mr. MARTIN. Mr. Speaker, I withdraw my reservation of objection.

The SPEAKER. Is there objection to the request of the gentleman from Arkansas?

There was no objection.

The Clerk read the bill, as follows:

Be it enacted, etc., The National Science Foundation is authorized and directed to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightening, fog, tornadoes, or other weather phenomena, and to report annually to the President and the Congress thereon. In conducting such studies, the Foundation shall consult with meteorologists and scientists in private life and with agencies of Government interested in, or affected by, experimental research in the field of weather control. Research programs to carry out the purposes of this act by the National Science Foundation, and by other Government agencies or departments, may be accomplished through contract with, or grants to, private or public institutions or agencies, including but not limited to cooperative programs with any State through such instrumentalities as may be designated by the governor of such State.

SEC. 2. For the purposes of this act, the Foundation is authorized to accept as a gift, money, material, or services: *Provided,* That any such gift may, if the donor so specifies, be restricted or limited for use in connection with certain projects or areas. Other agencies of the Government are authorized to loan, without reimbursement, and the Foundation is authorized to receive, such property, and personnel as may be deemed useful, with the approval of the Director of the Bureau of the Budget. In addition to the authority contained herein, the National Science Foundation, for the purposes of this act, may utilize any of the powers granted by the National Science Foundation Act of 1950 (42 U. S. C. 1861–75).

SEC. 3. The Advisory Committee on Weather Control is abolished effective December 31, 1957, and its functions, duties and records and any unexpended funds are transferred to the National Science Foundation and there is authorized to be appropriated to the National Science Foundation, such amounts as are necessary to carry out the purposes of this act.

With the following committee amendment:

Strike out all after the enacting clause and insert "That subsection (a) of section 3 of the National Science Foundation Act of 1950, as amended, is amended by striking out 'and' at the end of paragraph (7), by striking out the period at the end of paragraph (8) and inserting in lieu thereof a semicolon, and by adding after paragraph (8) the following new paragraph:

"'(9) to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena, and to report annually to the President and the Congress thereon.'

"SEC. 2. The National Science Foundation Act of 1950, as amended, is amended by changing the designations of sections 14, 15, and 16 (and all reference to such sections in any provision of law) to 15, 16, and 17, respectively, and by inserting after section 13 the following section:

"'WEATHER MODIFICATION

"'SEC. 14. (a) In carrying out the provisions of paragraph (9) of section 3 (a), the Foundation shall consult with meteorologists and scientists in private life and with agencies of Government interested in, or affected by, experimental research in the field of weather control.

"'(b) Research programs to carry out the purposes of such paragraph (9), whether conducted by the Foundation or by other Government agencies or departments, may be accomplished through contracts with, or grants to, private or public institutions or agencies, including but not limited to cooperative programs with any State through such instrumentalities as may be designated by the governor of such State.

"'(c) For the purposes of such paragraph (9), the Foundation is authorized to accept as a gift, money, material, or services: *Provided,* That notwithstanding section 11 (f), use of any such gift, if the donor so specifies, may be restricted or limited to certain projects or areas.

"'(d) For the purposes of such paragraph (9), other agencies of the Government are authorized to loan to the Foundation without reimbursement, and the Foundation is authorized to accept and make use of, such property and personnel as may be deemed useful, with the approval of the Director of the Bureau of the Budget.

"'(e) The Director of the Foundation, or any employee of the Foundation designated by him, may for the purpose of carrying out the provisions of such paragraph (9) hold such hearings and sit and act at such times and places and take such testimony as he shall deem advisable. The Director or any employee of the Foundation designated by him may administer oaths or affirmations to witnesses appearing before the Director or such employee.

"'(f) (1) The Director of the Foundation may obtain by regulation, subpena, or otherwise such information in the form of testimony, books, records, or other writings, may require the keeping of and furnishing such reports and records, and may make such inspections of the books, records, and other writings and premises or property of any person or persons as may be deemed necessary or appropriate by him to carry out the provisions of such paragraph (9), but this authority shall not be exercised if adequate and authoritative data are available from any Federal agency. In case of contumacy by, or refusal to obey a subpena served upon, any person referred to in this subsection, the district court of the United States for any district in which such person is found or resides or transacts business, upon application by the Director, shall have jurisdiction to issue on order requiring such person to appear and give testimony or to appear and produce documents, or both; and any failure to obey such order of the court may be punished by such court as a contempt thereof.

"'(2) The production of a person's books, records, or other documentary evidence shall not be required at any place other than the place where such person usually keeps them, if, prior to the return date specified in the regulations, subpena, or other document issued with respect thereto, such person furnishes the Foundation with a true copy of such books, records, or other documentary evidence (certified by such person under oath to be a true and correct copy) or enters into a stipulation with the Director as to the information contained in such books, records, or other documentary evidence. Witnesses shall be paid the same fees and mileage that are paid witnesses in the courts of the United States.

"'(3) Any person who willfully performs any act prohibited or willfully fails to perform any act required by the above provisions of this subsection, or any regulation issued thereunder, shall upon conviction be fined not more than $500.

"'(4) Information contained in any statement, report, record, or other document furnished pursuant to this subsection shall be available for public inspection, except (A) information authorized or required by statute to be withheld and (B) information classified in accordance with law to protect the national security. The foregoing sentence shall not be interpreted to authorize or require the publication, divulging, or disclosure of any information described in section 1905 of title 18 of the United States Code, except that the Director may disclose information described in such section 1905, furnished pursuant to this subsection, whenever he determines that the withholding thereof would be contrary to the purposes of this section and section 3 (a) (9) of this act.'"

Mr. HARRIS (interrupting the reading). Mr. Speaker, I ask unanimous consent that further reading of the amendment be dispensed with and that it be printed in full in the record.

The SPEAKER. Without objection, it is so ordered.

There was no objection.

Mr. HARRIS. Mr. Speaker, I move to strike out the last word.

Mr. Speaker, the bill S. 86, would provide for a comprehensive weather modification research program under the direction of the National Science Foundation. As it came to the House from the other body it had a particular provision as to the approach to this problem which the Committee on Interstate and Foreign Commerce considered, and in view of the information which the committee developed during the course of the hearings it was decided most appropriate that new language be provided to make a little more definite and clear the intent and purpose of the bill.

As originally introduced the bill would have extended the Advisory Committee on Weather Control for 5 years. The Senate Committee amended the bill to set up the program under the National Science Foundation, a permanent agency of the Federal Government well equipped to conduct the research necessary to get the facts regarding this problem.

The Advisory Committee on Weather Control was established by the act of August 13, 1953. That legislation was the outgrowth of congressional hearings between 1951 and 1953 on the important subject.

Those hearings revealed that farmers, ranchers, electric utilities, municipalities and other water users were paying somewhere between 3 and 5 millions of dollars a year on weather-modification activities covering approximately 10 percent of the land area of the Nation. Those hearings indicated a necessity for an impartial evaluation of these extensive weather modification, or cloud-seeding operations to learn if these operations were producing favorable or other results. There was no existing agency to do this.

The Advisory Committee, which went out of existence last December 31, made a comprehensive report to the President. That report indicated a further study of the problem is needed and the Advisory Committee recommended the enactment of this legislation.

In its final report, the Advisory Committee posed this question: "In the absence of any clear-cut statistical conclusions, a farmer in a Midwestern State is still faced with the question: Should he buy commercial cloud-seeding services"?

This bill is intended to try to get the best answer to that question possible and to develop other facts of national importance.

The Subcommittee on Health and Science of the Committee on Interstate and Foreign Commerce held hearings March 18 and 19 on this legislation. Leading experts in the field were heard. No one appeared in opposition. All of the Federal agencies concerned recommend favorable action on the legislation. After consideration, the subcommittee recommended an amendment to the Senate bill to write the proposed legislation into the National Science Foundation Act. This is a technical amendment and is not intended to make any substantive changes in the Senate bill.

Our committee feels that this problem of weather modification is of such magnitude that scientifically controlled experiments are necessary on such a broad scale that only a Federal program is adequate. It is basically a national problem. The committee knows of no agency better qualified to undertake this study than the National Science Foundation.

That is precisely what this legislation would do.

Mr. DIXON. Mr. Speaker, I rise in opposition to the pro forma amendment.

Mr. Speaker, this measure in my opinion is fully as important as research in guided missiles, because air currents are likely to be changed, droughts are likely to be brought upon us by our activities, and floods which would wash out our dams and projects.

I commend the committee on working it out. I think it is a remarkable measure.

One other thing: 70 percent of our forest fires are caused by lightning. We have had 29 experiments on cloud-seeding that would dispel clouds rather than accumulate them, wherein they cause lightning. Out of these experiments, 19 have been very successful. Our Forest Service is extremely anxious that this measure be passed.

On February 3, 1958, I met at the White House with a few interested Congressmen and members of the Advisory Committee on Weather Control at the formal presentation of their final report to the President. I came away from this meeting more convinced than ever of the urgent need for an expanded, sustained, fundamental research program in weather control. Following are some of my reasons:

First. We have definitely made progress in weather control.

About 10 weeks ago 2 scientists, including Nobel Prize winner Dr. Irving Langmuir, succeeded in creating a snowstorm by dropping dry ice pellets from an aircraft into a super-cooled cumulus cloud. This successful flight was the result of 5 or 6 years of exhaustive research at Mount Washington, N. H., and General Electric representatives at Schenectady, N. Y.

Since then there has been a spate of rainmakers, some of whom made fantastic claims with little scientific knowledge of weather modification.

Since weather control offered promise but had also proved disappointing to many farmers who had paid for cloud seeding, the Advisory Committee on Weather Control was established to study weather modification without preconceived notions. It examined all the evidence with a scholarly care and a scientific impartiality. I would like to quote the summary of findings of this venerable committee which is found in the preface to volume 1 of the final report:

A. On the basis of its statistical evaluation of wintertime cloud seeding using silver iodide as the seeding agent, the committee concluded that:

(1) The statistical procedures employed indicated that the seeding of winter-type storm clouds in mountainous areas in western United States produced an average increase in precipitation of 10 to 15 percent from seeded storms with heavy odds that this increase was not the result of natural variations in the amount of rainfall.

(2) In nonmountainous areas, the same statistical procedures did not detect any increase in precipitation that could be attributed to cloud seeding. This does not mean that effects may not have been produced. The greater variability of rainfall patterns in nonmountainous areas made the techniques less sensitive for picking up small changes which might have occurred there than when applied to the mountainous regions.

(3) No evidence was found in the evaluation of any project which was intended to increase precipitation that cloud seeding has produced a detectable negative effect on precipitation.

(4) Available hail frequency data were completely inadequate for evaluation purposes and no conclusions as to the effectiveness of hail suppression projects could be reached.

B. On the basis of its physical evaluations, the committee concluded that:

(1) The conventional seeding with silver iodide generators on the ground is a valid technique for producing ice crystals in favorable summer and winter storm situations. (Formation of ice crystals is thought to be essential for the initiation of precipitation from most cold clouds. However, it is relevant to observe that precipitation does not necessarily follow.)

(a) Measurements of silver iodide particle concentrations at points several miles distant from the generators were compared with the estimated concentrations there. On the basis of the limited tests made, it was found that the rate of deactivation was low enough to be of no great concern for practical seeding, even during the adverse decay conditions of bright sunlight and warm temperatures.

(b) Silver iodide particles in sufficient concentrations to produce seeding effects were found at distances up to 30 miles from the ground generators in particular tests.

(2) Measurements and cloud observations in various regions throughout the United States have indicated that sometimes there is a deficiency of natural ice forming particles effective at the temperatures at which ice crystals are formed on silver iodide.

We are fortified in the conclusion that significant progress has been made in weather modification by a statement of the American Meteorological Society on April 30, 1957:

1. The seeding of a supercooled cloud with dry ice will usually convert at least a portion of the cloud to ice crystals. Under appropriate conditions, such seeding may release variable amounts of precipitation. * * *

2. The injection of water drops or hydroscopic salt particles into active, warm (nonsupercooled) cumulus clouds may release some rain. * * *

3. In some cases warm fog and stratus may be dissipated in restricted regions by the use of certain hygroscopic materials.

4. At temperatures below about −5° centigrade silver iodide crystals are known to affect supercooled clouds in much the same way as dry ice. * * *

5. Cloud seeding acts only to trigger the release of precipitation from existing clouds. * * *

6. No convincing evidence has been presented which indicates that ground-based silver iodide seeding affects the amount or character of precipitation over flat country. (Mountain country is different.)

* * * * *

9. All cloud-seeding operations should be considered as experiments since the techniques are still under development and there is no sound basis for the quantitative estimation of the results in advance of the operation. * * * There is good reason to believe that improved returns from cloud seeding will result from a sound experimental approach and this should be fostered by all concerned.

President Eisenhower has shown personal interest in weather control and on July 18, 1957, he wrote Captain Orville, chairman, Advisory Committee on Weather Control:

Of particular interest was your indication of the probability that, at least along the western coasts, increased precipitation might be expected from cloud seeding operations. I can readily appreciate the importance such production of additional water supplies might have in helping to ease the Nation's emerging problem of growing scarcity of water resources in many areas.

Second. Droughts incur terrible hardship and should be remedied if possible.

One of the deepest impressions of my life has been to visit the 25 counties of my district during the congressional recesses, especially during 1955 and 1956, and see the despair written on the faces of so many of our fine, industrious Utah farmers. This drought, which was probably the greatest in American history, not only involved human misery but was a great economic loss to the Nation.

For example, the amount of emergency credit given by the Farmers Home Administration for the 4½-year period ending December 30, 1957, amounted to $318,525,517. The emergency feed program, which also operated in serious drought areas, cost $221,282,012, and the hay and ruffage program cost an additional $35,289,000. The Federal Government also spent $184 million to bolster livestock prices during a recent 3-year period primarily required because of the drought. The emergency ACP payments for land damaged by wind erosion, primarily due to drought, cost $17,956,000. Emergency feed distribution programs of the USDA, a significant share of which was for drought, amounted to $156,254,376.

These costs to the taxpayer are only a minute fraction of the billions of dollars

of economic loss to the farmers and other citizens of the drought-stricken States. The estimate has been made that nearly 29 million acres of land in the Great Plains States are quoted "conditioned to blow away for lack of protective plant cover."

Third. Weather control can help reduce other types of damage.

Not only is there a prospect of increasing precipitation in times of drought emergency, but enormous damage is produced by hailstorms, hurricanes, and forest fires caused by lightning. Approximately 70 percent of forest fires, with their costly damage to our timber resources, is caused by lightning. The research on cloudseeding is related to research in these other areas.

Fourth. We must beat Russia to the punch.

H. G. Wells once wrote:

Human history becomes more and more a race between education and catastrophe.

Dr. Edward Teller has stated that if the present trend continues in 10 years the best scientists in the world will be Russian. This would be a disaster for freedom and human feelings. America could become as subject to Russia's whims as a rat in a laboratory to an experimenter. If Russia beats us to the punch on learning how to control the natural laws governing weather changes, they could conceivably produce a drought over our whole continent or a disastrous flood. We know that the Russians are devoting great energy and scientific talent to learning how to control the weather. It is urgent that the United States not fall behind in this race.

There are many calls upon Congress to meet the needs of the post-sputnik world. We must consider in these serious calls what the expected benefit as well as the cost of any project will be. In the problem of weather control I believe the stakes are enormous and the cost is a relatively minor thing. Consequently, this should have high priority in our changing pattern of scientific research. Furthermore, basic research over a long and extended period of time is necessary for purposes of comparison in the area of weather modification. So it is urgent that Congress pass S. 86 to pave the way for a permanent, substantial weather research program conducted by the National Science Foundation in cooperation with other agencies.

(Mr. DIXON asked and was given permission to revise and extend his remarks.)

Mr. BERRY. Mr. Speaker, I move to strike out the last word.

Mr. Speaker, I appreciate this opportunity to urge my colleagues in the House to support S. 86. I had joined with Senator FRANCIS CASE, of South Dakota, in the introduction of this legislation, and have been very gratified by the unanimous approval it has received in the Senate, in the Interstate and Foreign Commerce Committee, and in the Rules Committee. I hope the House will today concur in this action, thus clearing it for the President, after minor differences have been resolved.

Since the time man was created, water has been the most valuable commodity to the human race. As populations increased, it became necessary for man to grow crops to provide food rather than depend on the provisions of nature. Since that time, the existence of prosperity or famine have been largely dependent on rainfall and wise use of available water.

We in this country annually spend millions of dollars for drought relief. We spend millions more for flood relief, and beyond that there are untold millions lost in flood and drought damage.

If the clouds could be modified so that rain could be produced in time of drought or clouds dissipated to prevent disastrous floods, the investment of a comparatively small amount of money would be a wise investment. Even the benefits of more accurate and long-range forecasting offer tremendous returns for efforts expended even though we did not have the possibility of modifying the weather in any other particular.

The use of water in America has more than doubled since the turn of the century. Annually we spend millions of dollars trying to discover new water resources and to better utilize those that we already have, while in the sky there is a reservoir of uncounted billions of gallons of sweet, fresh, clear water that nature may not drop where it is most needed. It seems to me we ought to provide the experimentation program so that this generation and those following can successfully tap that source of supply, and to do what can be done to see that the supply falls where it is needed and does not fall where it will do damage.

Mark Twain once said:

Everyone talks about the weather, but no one does anything about it.

This is no longer true as cloud seeding to increase rainfall has become a miracle of our fantastic age. There is no question but what the method of seeding silver iodide particles in clouds has produced rain, but we must now determine the extent to which this discovery can be used to benefit mankind and the degree of accuracy that can be attained in bringing down the life-giving moisture from the heavens. The purpose of this bill is to provide for a thorough study of the accomplishments as well as the potential of cloud modification and weather modification.

The American Meteorology Society has recently released a statement on weather modification which outlines the general opinion of the field of meteorology on this matter. The Society, composed of nearly 6,500 members representing weathermen throughout America, from private industry, from universities, and from Government weather service, probably represents the best thinking and the greatest amount of knowledge and information on this subject. Their recent statement on the scientific aspects of weather modification and weather control is as follows:

1. The seeding of a supercooled cloud with dry ice will usually convert at least a portion of the cloud to ice crystals. Under appropriate conditions, such seeding may release variable amounts of precipitation from fairly deep and active cumulus clouds in which the natural release of precipitation has not already started. Small, inactive cumulus clouds are usually dissipated when they are seeded with dry ice. Holes or valleys may be produced in supercooled layer clouds of supercooled fogs by seeding them with dry ice.

2. The injection of water drops or hygroscopic salt particles into active, warm (nonsupercooled) cumulus clouds may release some rain. Small, inactive, warm cumulus may often be partially or completely dissipated by seeding them from above with water drops or other particles; such dissipation may occasionally be accompanied by the release of very light rain.

3. In some cases warm fog and stratus may be dissipated in restricted regions by the use of certain hygroscopic materials.

4. At temperatures below about −5° C. silver iodide crystals are known to affect supercooled clouds in much the same way as dry ice. The frequent absence of clear-cut results following the operation of ground-based silver iodide generators is believed to be due to one or more of the following causes: (a) the failure of the seeding material to reach the supercooled clouds, (b) the absence of clouds that could be affected by seeding, (c) the decay of the silver iodide, (d) the presence of an ample supply of natural ice crystals, (e) topographical influences which defy quantitative measurement.

5. Cloud seeding acts only to trigger the release of precipitation from existing clouds. The release of substantial amounts of precipitation by either natural or artificial means requires the prexistence of an extensive moisture supply in the form of moist air currents and of active cloud-forming processes. For this reason the meteorological conditions most favorable for the artificial release of precipitation are very much the same as those which usually lead to the natural release of precipitation. This factor plus the extreme natural variability of precipitation makes the evaluation of the effects of seeding difficult and often inconclusive.

6. Evaluations performed by independent agencies have yielded reasonably convincing evidence of increases of precipitation due to the operation of ground-based silver iodide generators only for operations conducted in cold weather in regions where forced lifting of the air over a mountain range is an important factor. No convincing evidence has been presented which indicates that ground-based silver iodide seeding affects the amount or character of the precipitation over flat country. This does not prove that there are no such effects but suggests that, if present, they are too small to be detected by statistical analyses of data available to this date.

7. In the absence of a truly quantitative theory of precipitation, the best present means of obtaining a quantitative estimate of the effect of seeding on precipitation is through the statistical evaluation of randomized cloud seeding experiments. The randomization is necessary to insure valid interpretations of the results and a long series of such experiments may be necessary to detect small effects.

8. Present knowledge of atmospheric processes offers no real basis for the belief that the weather or climate of a large portion of the country can be significantly modified by cloud seeding. It is not intended to rule out the possibility of large-scale modifications of the weather at some future time, but it is believed that, if possible at all, this will require methods that alter the large-scale atmospheric circulations, possibly through changes in the radiation balance.

9. All cloud seeding operations should be considered as experiments since the techniques are still under development and

there is no sound basis for the quantitative estimation of the results in advance of the operation. As experiments they should be designed primarily to yield optimum scientific results. There is good reason to believe that improved returns from cloud seeding will result from a sound experimental approach and this should be fostered by all concerned.

There has been generated in this country an almost hysterical desire to control outer space, yet the control of the atmosphere is probably many times more important than outer space. This bill provides a means by which we can develop a control of the atmosphere. It provides that basic research be established under the National Science Foundation, and directs the Foundation to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornados, hurricanes, and other weather phenomena. It also directs that they report annually to the President and to the Congress, and it grants to the Foundation the power and authority which is needed in order to carry out such a program effectively.

The legislation would, Mr. Speaker, continue and expand under a permanent operating agency of Government, namely, the National Science Foundation, a research program conducted by the Advisory Committee on Weather Control, which was established by the 83d Congress.

It would permit the National Science Foundation to make grants to, or contracts with, public or private institutions or agencies, including cooperative programs with States. At the present time no Federal agency has specific legislative authority or funds to carry out such a program of basic and applied research in the field of weather modification.

The bill also directs the National Science Foundation to make available for public inspection all such information and data as is accumulated by them unless there is good reason to the contrary because of security circumstances. It also directs the Foundation to strengthen basic research and education in the sciences, including independent research by individuals throughout the United States, and to render an annual report to the President prior to the 15th of January of each year. It provides that such report shall include minority views and recommendations, if any, of members of the Board, and information as to the acquisition and disposition by the Foundation of any patents and patent rights.

Mr. Speaker, America has already demonstrated what can be accomplished in the race for space when we set our minds and our efforts toward that goal. This bill establishes the machinery for a similar program to learn how to control the atmosphere, which is equally important for both military and economic purposes.

It should be pointed out, Mr. Speaker, that in the hearings in both the House and the Senate not one single witness appeared in opposition to the passage of this bill. It seems to me that this unanimous endorsement of this legislation testifies as to its importance and the desire on the part of both lay and scientific citizens to learn more about what man can do to assist nature in providing the necessary water in the areas where man has chosen to live rather than where nature has chosen to deposit its water resources.

(Mr. BERRY asked and was given permission to revise and extend his remarks.)

Mr. ROGERS of Florida. Mr. Speaker, I move to strike out the last word.

Mr. Speaker, the people of Florida, as the rest of the Nation, depend on good weather and good weather forecasting in their everyday lives. The effects of tropical hurricanes and floods constitute a realistic threat to our crops, industry, and the welfare of our citizens and visitors.

Legislation of the type presently before the House, S. 86, will add to the understanding of weather, its improved forecasting, and eventual modification. All sections of the country are vitally interested in this program, because of the ravages of bad weather, such as drought, flood, tornadoes, and the other devastating forces of nature on the rampage.

The Nation's defense effort will benefit from this measure because weather information, research, and modification is of such great importance to the operations of the Military Establishment.

Every American looks forward to the day when the weather will work for us in our jobs and recreation, and this bill will be a big step in the right direction, by establishing a sound program for study and evaluation in the field of weather modification.

The pro forma amendments were withdrawn.

Mr. ROOSEVELT. Mr. Speaker, I move to strike out the last word.

Mr. Speaker, I would like to ask the gentleman whether the bill is broad enough to take advantage of the Stamford research program which, as I understand it, is envisioned to control the weather to the west of the western border of the United States in the Pacific and thereby bring additional rain to the western portion of the country.

Mr. HARRIS. I would say to the gentleman that the basis of this resolution is to do something about the fire hazards in our great forests in this country. That is the prime purpose of it. However, there is a provision in the bill which would permit the National Science Foundation to foster the interchange of scientific information among scientists in the United States and foreign countries. So the answer to the gentleman's question is that it would.

Mr. ROOSEVELT. I thank the gentleman.

GENERAL LEAVE TO EXTEND

Mr. HARRIS. Mr. Speaker, I ask unanimous consent that all Members may be permitted to extend their remarks at this point.

The SPEAKER. Is there objection to the request of the gentleman from Arkansas?

There was no objection.

Mr. McGOVERN. Mr. Speaker, I rise in support of the committee bill to provide for a research program in the field of weather modification, to be conducted by the National Science Foundation.

Some time ago, I appeared before the subcommittee of the Committee on Interstate and Foreign Commerce which reported this bill. At that time, I spoke very strongly in favor of the legislation because of my conviction that we must miss no opportunity to make maximum use of our water and land resources.

I have grown up in the State of South Dakota, a State with abundant agricultural resources that produces much of the Nation's food. I have experienced, however, as have our farmers, the discouraging results of scant rainfall. We have known years when it was virtually impossible to produce the good things that are necessary to sustain the dining tables of America.

This bill seeks to explore the possibilities of weather control and modification with the end in view of encouraging rainfall in areas of low precipitation. Much worth-while investigation has already been conducted in this field. We do not know all of the answers as yet, but it seems clear to me that we ought to accelerate our study, investigation, and research in this potentially profitable field.

I strongly urge passage of the bill.

Mr. RHODES of Pennsylvania. Mr. Speaker, the purpose of this legislation is to set up a program of research in weather modification under the National Science Foundation.

As introduced in the other body, S. 86 would have extended the Advisory Committee on Weather Control and provided a 5-year, $5-million study of weather control. As amended, the bill would provide for continuation of the program by a permanent agency of the Federal Government.

The Advisory Committee on Weather Control was established by Public Law 256, 83d Congress to study and evaluate various experiments indicating that man can modify clouds and cause precipitation by various means and under certain conditions.

The committee, which went out of existence last December 31, in its final report recommended the enactment of S. 86. In evaluating studies and operations in mountainous regions of the west coast of the United States under selected conditions, the committee reported that—

> The evidence indicates that cloud seeding has produced an average increase of 10- to 15-percent in the precipitation from seeded storms.

As for other regions, however, the report stated that—

> The same procedures and testing methods did not detect any change in the precipitation—

That could be attributed to cloud seeding. The report added:

> But the fact that no increase in precipitation was detected does not warrant the conclusion that there was no increase; the increase may have been too slight to measure by the statistical methods used. In these areas, analytical difficulties are multiplied by the complicated rainfall processes in contrast to the comparatively simple west coast rainfall process.

Later in the report, the Advisory Committee pointed out that—

In the absence of any clear-cut statistical conclusions, a farmer in a Midwestern State is still faced with the question: Should he buy commercial cloud seeding services?

Mr. Speaker, inasmuch as research in weather modification involves problems of such scope and magnitude that they can be studied adequately only by a well-coordinated Federal program, the committee has recommended enactment of S. 86.

S. 86 passed the Senate without opposition. A subcommittee of the House Committee on Interstate and Foreign Commerce held hearings March 18 and 19 of this year, at which time, leading experts in this field appeared and testified in favor of the legislation. There was no opposition. Affected Government agencies recommended favorable action.

The House amendment, to strike out all after the enacting clause, is technical in nature. The amendment is not intended to change the purpose or scope of the Senate bill. As passed by the Senate the bill authorized and directed the National Science Foundation to undertake the program and authorized the transfer of certain functions of the Advisory Committee on Weather Control to the National Science Foundation. However, the advisory committee has now gone out of existence. Transferring functions of an organization no longer in existence presented difficulties. Accordingly, the committee decided to rewrite the Senate bill as an amendment to the National Science Foundation Act.

Mr. Speaker, to reach correct conclusions on this important problem, scientifically controlled experiments are necessary. These must include both basic research and actual field tests.

In a statement presented at the hearings, Dr. Alan T. Waterman, Director, National Science Foundation, outlined the problem as follows:

I am familiar with the problems involved, not only as Director of the National Science Foundation but also from having been a member of the Advisory Committee on Weather Control. From the evaluation activities of the advisory committee, evidence to date seems clearly to indicate that no large rain-producing effects will be achieved by present means without further basic research to acquire a much fuller understanding of the processes by which nature produces rain or snow. Ability to modify weather including control of precipitation, presupposes accurate knowledge of what would happen at a predetermined time if we did not attempt modification. The word "modify" means "change"—changing something that we know in advance would happen naturally. Clearly better understanding is also needed for accurate prediction.

It is my view, both from the studies of the committee and from consideration given to the subject in the Foundation, that by far the most important element toward effective progress in weather modification at this time lies in a planned program in support of research by competent scientists on the fundamental problems dealing with the precipitation process.

In outlining a proposed program to carry out the responsibilities which would be given the Foundation by this legislation, Dr. Waterman stated:

If S. 86 is enacted, the National Science Foundation intends to press, as a matter of priority, for further effective basic research in the general area of weather modification, particularly in the fields of cloud physics and meteorology. It will carry forward evaluation programs begun by the Advisory Committee on Weather Control, and to the extent that sufficient scientific knowledge is available, initiate and support such applied research or development work as may appear reasonably promising. In undertaking the applied research and development activities, the Foundation would welcome and expect the cooperation of other Government agencies, such as the Departments of Defense, Interior, and Agriculture, and the Weather Bureau. It is my understanding that under S. 86 the Foundation could transfer funds to such agencies for these purposes.

The question of how much this program is going to cost was raised in the hearings by the gentleman from Michigan [Mr. DINGELL], when he asked Dr. Paul Klopsteg, associate director of the National Science Foundation, the following question:

I have been doing some thinking here about two things. First, what is the amount and the extent of the program that you propose to carry out under this specific piece of legislation, dollar-and-cents-wise? Here we are dealing with a blank check. I would like to know what you folks proposed to do with this after we pass this legislation.

Dr. Klopsteg's answer was as follows:

It is a little bit early to prognosticate figures with any degree of confidence, but let me say that as we move into this field more vigorously—we have already been supporting some projects in meteorology as part of our earth-sciences program—we would expect that during the first year of operation for which funds might be asked, we could perhaps usefully apply somewhere near a million dollars. This amount, depending upon the wisdom with which the program is managed and in terms of the advice given us, might grow somewhat during the succeeding years.

The first version of S. 86, as I recall it, provided for $5 million to be authorized for a 5-year program. I think that we can use that as a point of departure to guide our thinking as to the amount involved.

Mr. Speaker, it should also be pointed out that the committee substitute contains important language dealing with the availability of information obtained by the foundation under this legislation.

The committee has given considerable attention to this matter, in view of the censorship abuses uncovered by the Special Subcommittee on Government Information of the House Government Operations Committee. Under the chairmanship of the distinguished gentleman from California [Mr. Moss], this subcommittee has done outstanding work in asserting the right of the press and individual citizens to information concerning the affairs of the executive agencies and departments of our Government.

Generally speaking, the committee has taken the position that all information furnished under this act should be available for public inspection unless there is some good reason to the contrary. The committee was in full agreement with the need to keep information confidential if disclosure would conflict with the national security. Language has been provided in the bill at subsection (f) (4) of the new section 14, which the committee substitute proposes to insert into the National Science Foundation Act. This subsection reads:

(4) Information contained in any statement, report, record, or other document furnished pursuant to this subsection shall be available for public inspection, except (A) information authorized or required by statute to be withheld, and (B) information classified in accordance with law to protect the national security. The foregoing sentence shall not be interpreted to authorize or require the publication, divulging, or disclosure of any information described in section 1905 of title 18 of the United States Code, except that the Director may disclose information described in such section 1905, furnished pursuant to this subsection, whenever he determines that the withholding thereof would be contrary to the purposes of this section and section 3 (a) (9) of this act.

Similar provisions providing for public access to information have been written into H. R. 12575, the National Aeronautics and Outer Space Act of 1958—section 503—and the Senate version of this bill, S. 3603, the National Aeronautics and Space Act of 1958—section 302.

Clauses (A) and (B) of this subsection provides adequate safeguards against the release of data classified for security purposes. The language of subsection (f) (4) otherwise makes possible the widest possible dissemination of information on weather modification, so important to both the public and to the scientists working in this field.

Mr. Speaker, the potential long-range importance of weather modification makes it imperative that we act promptly to authorize the research program provided for in this legislation.

The SPEAKER. The question is on the committee amendment.

The committee amendment was agreed to.

The SPEAKER. The question is on the third reading of the bill.

The bill was ordered to be read a third time and was read the third time.

The SPEAKER. The question is on the passage of the bill.

The bill was passed.

The title was amended so as to read: "An act to amend the National Science Foundation Act of 1950, to provide for a program of study, research, and evaluation in the field of weather modification."

A motion to reconsider was laid on the table.

CONSTRUCTION OF PUBLIC AIRPORT IN OR NEAR DISTRICT OF COLUMBIA

Mr. HARRIS. Mr. Speaker, I ask unanimous consent for the immediate consideration of the bill (H. R. 12311) to amend the act of September 7, 1950 (relating to the construction of a public airport in or near the District of Columbia), to remove the limitation on the amount authorized to be approriated for construction.

The Clerk read the title of the bill.

The SPEAKER. Is there objection to the request of the gentleman from Arkansas?

There was no objection.

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Senate conferees were appointed (p. 11615). House conferees have not been appointed.

14. CIVIL DEFENSE. Passed without amendment H. R. 12827, to extend the standby emergency authorities of the Federal Civil Defense Administration until June 30, 1962. A similar bill, S. 4602, was indefinitely postponed. This bill will now be sent to the President. p. 11581

15. WEATHER CONTROL. Concurred in the House amendments to S. 86, to authorize a weather modification research program under the direction of the National Science Foundation. This bill will now be sent to the President. pp. 11581-4

16. GRAIN STANDARDS. Concurred in the House amendments to S. 2007, to amend the Grain Standards Act to permit the collection of charges to reimburse the Department for overtime, travel, and certain other costs in connection with handling inspection appeals. This bill will now be sent to the President. pp. 11626-7

17. APPROPRIATIONS. Passed as reported H. R. 12948, the D. C. appropriation bill for 1959. pp. 11584-9

18. TRADE AGREEMENTS. Sens. Sparkman and Watkins discussed the state of the textile industry, import competition, and the President's letter to House Speaker Martin in 1955 promising to administer the Reciprocal Trade Agreements Program to benefit the American economy and not jeopardize any industry. pp. 11617-18

19. PERSONNEL. The Post Office and Civil Service Committee ordered reported S. 4004, to encourage the transfer of Federal employees for service with International organizations, and H. Con. Res. 175, to establish a code of ethics for Government personnel. p. D620

20. STATEHOOD. Sen. Smith, N. J., commended passage of the Alaska statehood bill. p. 11559

Sens. Church and Neuberger commended the efforts of certain Alaskans in the passage of the Alaskan statehood bill. pp. 11627-9

Sen. Watkins urged statehood for Hawaii. p. 11629

21. FLORAL EMBLEM. Sen. Douglas urged adoption of the golden corn tassel as the national floral emblem, read a poem, "Columbia's Emblem," and inserted an article on the importance of corn in America. pp. 11562-3

22. MINERALS. S. 3817, to provide stabilization payments to mineral producers, remained the Senate's unfinished business. pp. 11587, 11589, 11616, 11626.

23. LEGISLATIVE PROGRAM. Sen. Mansfield stated that S. 3916, to extend for 2 years provisions of the Shipping Act of 1916 relating to dual rate contract arrangements, would be considered Wed. or Thurs. (p. 11629).

ITEMS IN APPENDIX

24. ELECTRIFICATION. Sen. Sparkman inserted an article describing the headway TVA has made in the repayment of funds advanced by Congress for various projects. pp. A5957-8

25. LANDS. Extension of remarks of Sen. Neuberger urging immediate passage of legislation for the orderly disposal of Klamath Indian lands, and inserting an article on this subject. pp. A5961-2

26. NATIONAL FLOWER. Rep. McIntosh inserted his statement in support of H. J. Res. 625, to designate the rose as our national flower. p. A5969

27. LAW. Rep. Lane inserted a AFL-CIO and a Railway Labor Executives' Ass;n letter opposing the passage of H. R. 3, to establish rules of interpretation governing questions of the effect of Acts of Congress on State laws. pp. A5970, A5972-3

28. STATEHOOD. Extension of remarks of Rep. Broomfield expressing "great pleasure" over the approval of statehood for Alaska. p. A5971

29. PRICE SUPPORTS. Extension of remarks of Rep. Johnson, Wis., commending and inserting an article, "Who Gets Government Subsidies?" and stating that "it goes into some detail to point out that many, many costs laid at the feet of the Nation's farmers are actually for programs which benefit all of us such as the forestry service; the school lunch; and milk program; ..." pp. A5981-2

BILLS INTRODUCED

30. PROPERTY. S. 4089, by Sen. Kerr (for himself and Sen. Monroney), to amend the Federal Property and Administrative Services Act of 1949 so as to permit donations of surplus property to libraries which are tax supported or publicly owned and operated; to Government Operations Committee.

H. R. 13230, by Rep. Dawson, Ill. (by request), to amend the Federal Property and Administrative Services Act of 1949, as amended, to promote the utilization of excess property and to simplify the reimbursement procedure for transfers of such property; to Government Operations Committee.

31. PROCEDURE. S. 4094, by Sen. Ervin (for himself and Sen. Butler), to recodify, with certain amendments thereto, chapter 19 of title 5 of the United States Code, "Administrative Procedure"; to Judiciary Committee.

32. BUILDINGS. H. R. 13231, by Rep. Ikard, to provide for the erection of a Federal and Post Office Building in Denton, Tex.; to Public Works Committee.

33. FLOOD CONTROL. H. R. 13236, by Rep. Byrne, Ill., to authorize the Secretary of the Army to conduct a flood control survey of the Stoney Creek watershed, Ill.; to Public Works Committee.

34. FORESTS. H. R. 13238, by Rep. Dixon, providing for the reconveyance to Salt Lake City, Utah, of the Forest Service fire warehouse lot in that city; to Agriculture Committee.

35. LANDS. H. R. 13251, by Rep. Miller, Neb., to provide that certain penalty charges against lands on Federal reclamation projects shall be nonreimbursable; to Interior and Insular Affairs Committee.

36. FOOD ADDITIVES. H. R. 13254, by Rep. Williams, Miss., to protect the public health by amending the Federal Food, Drug, and Cosmetic Act to probhit the use in food of additives which have not been adequately tested to establish their safety; to Interstate and Foreign Commerce Committee.

The amendments were agreed to.

The bill (S. 3499) was ordered to be engrossed for a third reading, read the third time, and passed.

CONSTRUCTION OF PUBLIC AIRPORT IN OR NEAR THE DISTRICT OF COLUMBIA

Mr. MANSFIELD. Mr. President, I ask unanimous consent that the Senate proceed to the consideration of Calendar No. 1798, H. R. 12311.

The PRESIDING OFFICE. The bill will be stated by title for the information of the Senate.

The LEGISLATIVE CLERK. A bill (H. R. 12311) to amend the act of September 7, 1950, relating to the construction of a public airport in or near the District of Columbia, to remove the limitation on the amount authorized to be appropriated for construction.

The PRESIDING OFFICER. Is there objection to the request of the Senator from Montana?

There being no objection, the Senate proceeded to consider the bill (H. R. 12311) to amend the act of September 7, 1950, relating to the construction of a public airport in or near the District of Columbia, to remove the limitation on the amount authorized to be appropriated for construction.

Mr. MAGNUSON. Mr. President, the bill merely adds to the authorization to build the second airport at Chantilly. The original authorization was only for the Burke airport. This bill will allow the full amount of the authorization. Of course, it will be necessary for the item to be presented to the Appropriations Committee as the airport progresses. We have to raise the ceiling amount because the original authorization applied only to Burke.

The PRESIDING OFFICER. If there be no amendment to be proposed, the question is on the third reading of the bill.

The bill (H. R. 12311) was ordered to a third reading, read the third time, and passed.

AMENDMENT OF PROVISIONS OF FEDERAL CIVIL DEFENSE ACT OF 1950

Mr. MANSFIELD. Mr. President, I ask unanimous consent that the Senate proceed to the consideration of Calendar No. 1796, H. R. 12827.

The PRESIDING OFFICER. The bill will be stated by title for the information of the Senate.

The LEGISLATIVE CLERK. A bill (H. R. 12827) to amend the provisions of title III of the Federal Civil Defense Act of 1950, as amended.

The PRESIDING OFFICER. Is there objection to the request of the Senator from Montana?

There being no objection, the Senate proceeded to consider the bill (H. R. 12827) to amend the provisions of title III of the Federal Civil Defense Act of 1950, as amended.

Mr. MANSFIELD. Mr. President, the bill now before the Senate would extend from June 30, 1958, until June 30, 1962, the provisions of title III of the Federal Civil Defense Act of 1950, as amended. The provisions that would be extended authorize the declaration of a national emergency for civil-defense purposes and vest emergency powers in the President and the Federal Civil Defense Administrator during such an emergency.

Mr. President, I ask unanimous consent that an excerpt from the House report be printed in the RECORD at this point.

There being no objection, the excerpt was ordered to be printed in the RECORD, as follows:

EXPLANATION

Section 301 of title III of the Federal Civil Defense Act of 1950, as amended, grants emergency authority during the existence of a state of civil-defense emergency. The existence of such an emergency may be proclaimed by the President or by concurrent resolution of the Congress if either finds that an attack upon the United States has occurred or is anticipated and that the national safety requires an invocation of such emergency authority. Any such emergency is terminable by proclamation of the President or a concurrent resolution by the Congress.

During a state of civil-defense emergency, the President and the Administrator may marshal all the resources of the Federal Government to meet the emergency conditions brought about by an enemy attack. The emergency powers include those of using Federal personnel and facilities, providing emergency shelter, repairing or restoring of vital utilities and facilities, broad Federal procurement and utilization authority over property, reimbursement of States for assistance given to other States, streamlined authority for the temporary employment of additional personnel without regard to the civil-service laws, financial assistance for temporary relief of civilians injured during an attack, and the incurring of such obligations on behalf of the United States as are required to meet the conditions created by the attack.

Constitutional safeguards regarding just compensation for nongovernmental property acquired are preserved and the immunity of the Federal Government from suit while performing these emergency functions is reserved.

During the period of any civil-defense emergency, the Administrator is required to transmit a quarterly report to the Congress covering all action taken pursuant to the emergency powers section.

The provisions of title III under the Federal Civil Defense Act of 1950 as it was originally enacted would have expired on June 30, 1954. Public Law 383 of the 83d Congress extended this termination date until June 30, 1958.

Since the possibility of an attack upon the United States with modern weapons of enormous destructive powers is at least as great today as when the standby emergency powers were originally authorized, this authority should not be allowed to expire.

COST DATA

Enactment of this measure would not directly involve the expenditure of Federal funds. It is impossible to estimate the cost involved if the emergency powers were used during or after an attack.

Mr. DIRKSEN. Mr. President, in connection with this bill, I wish to pay tribute to a former governor of Iowa, Leo A. Hoegh, who became Civil Defense Administrator, and who, in my judgment, has done an exceedingly forthright and competent job. He has an excellent "touch." I think his excellent qualifications and capabilities have been fully recognized by his appointment to the office of Director of the Office of Defense Mobilization.

The bill is an emergency proposal, and merely extends the time for the operation of an emergency agency. However, I am glad to take this opportunity to pay tribute to one who has given freely of his time and effort to energize this program and make the country conscious of the requirements of civil defense.

The PRESIDING OFFICER. The bill is open to amendment. If there be no amendment to be proposed, the question is on the third reading and passage of the bill.

The bill (H. R. 12827) was ordered to a third reading, read the third time, and passed.

The PRESIDING OFFICER. Without objection, Senate bill 4062 will be indefinitely postponed.

Mr. MANSFIELD. Mr. President, that concludes the call of the items on the calendar which were brought to the attention of the Senate last evening, with respect to which there was no objection.

I thank the acting minority leader for his cooperation in clearing this much proposed legislation.

RESEARCH PROGRAM IN FIELD OF WEATHER MODIFICATION

The PRESIDING OFFICER laid before the Senate the amendments of the House of Representatives to the bill (S. 86) to provide for a research program in the field of weather modification to be conducted by the National Science Foundation, and for other purposes, which were to strike out all after the enacting clause and insert:

That subsection (a) of section 3 of the National Science Foundation Act of 1950, as amended, is amended by striking out "and" at the end of paragraph (7), by striking out the period at the end of paragraph (8) and inserting in lieu thereof a semicolon, and by adding after paragraph (8) the following new paragraph:

"(9) to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena, and to report annually to the President and the Congress thereon."

SEC. 2. The National Science Foundation Act of 1950, as amended, is amended by changing the designations of sections 14, 15, and 16 (and all reference to such sections in any provision of law) to 15, 16, and 17, respectively, and by inserting after section 13 the following section:

"WEATHER MODIFICATION

"SEC. 14. (a) In carrying out the provisions of paragraph (9) of section 3 (a), the Foundation shall consult with meteorologists and scientists in private life and with agencies of Government interested in, or affected by, experimental research in the field of weather control.

"(b) Research programs to carry out the purposes of such paragraph (9), whether conducted by the Foundation or by other Government agencies or departments, may be accomplished through contracts with, or grants to, private or public institutions or agencies, including but not limited to co-

operative programs with any State through such instrumentalities as may be designated by the governor of such State.

"(c) For the purposes of such paragraph (9), the Foundation is authorized to accept as a gift, money, material, or services: *Provided*, That notwithstanding section 11 (f), use of any such gift, if the donor so specifies, may be restricted or limited to certain projects or areas.

"(d) For the purposes of such paragraph (9), other agencies of the Government are authorized to loan to the Foundation without reimbursement, and the Foundation is authorized to accept and make use of, such property and personnel as may be deemed useful, with the approval of the Director of the Bureau of the Budget.

"(e) The Director of the Foundation, or any employee of the Foundation designated by him, may for the purpose of carrying out the provisions of such paragraph (9) hold such hearings and sit and act at such times and places and take such testimony as he shall deem advisable. The Director or any employee of the Foundation designated by him may administer oaths or affirmations to witnesses appearing before the Director or such employee.

"(f) (1) The Director of the Foundation may obtain by regulation, subpena, or otherwise such information in the form of testimony, books, records, or other writings, may require the keeping of and furnishing such reports and records, and may make such inspections of the books, records, and other writings and premiscs or property of any person or persons as may be dcemed necessary or appropriate by him to carry out the provisions of such paragraph (9), but this authority shall not be exercised if adequate and authoritative data are available from any Federal agency. In case of contumacy by, or refusal to obey a subpena served upon, any person referred to in this subsection, the district court of the United States for any district in which such person is found or resides or transacts business, upon application by the Director, shall have jurisdiction to issue an order requiring such person to appear and give testimony or to appear and produce documents, or both; and any failure to obey such order of the court may be punished by such court as a contempt thereof.

"(2) the production of a person's books, records, or other documentary evidence shall not be required at any place other than the place where such person usually keeps them, if, prior to the return date specified in the regulations, subpena, or other document issued with respect thereto, such person furnishes the Foundation with a true copy of such books, records, or other documentary evidence (certified by such person under oath to be a true and correct copy) or enters into a stipulation with the Director as to the information contained in such books, records, or other documentary evidence. Witnesses shall be paid the same fees and mileage that are paid witnesses in the courts of the United States.

"(3) Any person who willfully performs any act prohibited or willfully fails to perform any act required by the above provisions of this subsection, or any regulation issued thereunder, shall upon conviction be fined not more than $500.

"(4) Information contained in any statement, report, record, or other document furnished pursuant to this subsection shall be available for public inspection, except (A) information authorized or required by statute to be withheld and (B) information classified in accordance with law to protect the national security. The foregoing sentence shall not be interpreted to authorize or require the publication, divulging, or disclosure of any information described in section 1905 of title 18 of the United States Code, except that the Director may disclose information described in such section 1905, furnished pursuant to this subsection, whenever he determines that the withholding thereof would be contrary to the purposes of this section and section 3 (a) (9) of this act."

And to amend the title so as to read: "An act to amend the National Science Foundation Act of 1950, to provide for a program of study, research, and evaluation in the field of weather modification."

Mr. MAGNUSON. Mr. President, I rise to move that the Senate concur in the amendments of the House of Representatives to Senate bill 86, which provides a program of basic research in the field of weather modification, the program to be conducted by the National Science Foundation.

The PRESIDING OFFICER. The question is on agreeing to the motion of the Senator from Washington.

Mr. MAGNUSON. Mr. President, the amendments made by the House in no way change the basic objectives of the Senate bill, but are necessary to take care of changes required by the passing of a whole year since the passage of the Senate bill.

I ask unanimous consent to have printed in the RECORD at this point as a part of my remarks an explanation of the House amendments. There are some minor changes, but they are changes which I know the Senate would approve, because of the different concept of the subject of weather control which has come about during the year since passage of the Senate bill.

There being no objection, the explanation was ordered to be printed in the RECORD, as follows:

S. 86, WEATHER CONTROL

Mr. President, I rise to move that the Senate accept amendments by the House to the bill, S. 86, to provide for a program of basic research in the field of weather modification, to be conducted by the National Science Foundation.

The amendments incorporated by the House in no way change the basic objectives of the Senate bill, but rather are directed to take care of changes made necessary by the lapse of nearly a year since the Senate approved the measure in August 1957.

For example, the House has eliminated language from the Senate bill directing that the activities of the Advisory Committee on Weather Control be transferred to the National Science Foundation. Since enactment of S. 86 by the Senate, the life of the Advisory Committee expired under authority of previous law, as of December 31, 1957. In line with this change, the House accomplished the purposes of the Senate bill by amending the National Science Foundation Act, whereas the Senate bill provided for the same program of weather research by the Foundation under separate statute.

Two other changes, minor in nature, were made by the House. On such change adds hurricanes to the weather phenomena the Foundation is authorized to study. The second involves a language change, in the interests of clarity, in connection with the release and publication of data gathered by the Foundation in the course of its authorized study.

I may state I have discussed my motion with the leaders on my own side of the aisle and with the minority of the Committee on Interstate and Foreign Commerce and we are in agreement.

Mr. CASE of South Dakota. Mr. President, will the Senator yield?

Mr. MAGNUSON. I yield.

Mr. CASE of South Dakota. As the Senator from Washington has said, the amendments of the House do not change the basic purposes of the bill. They do take into consideration the fact that the Weather Advisory Committee has passed out of existence. Primarily, the House amendments make the provisions of Senate bill 86 a part of the basic National Science Foundation Act. The purposes of the bill remain the same.

Mr. President, I ask unanimous consent to have printed in the RECORD at this point some remarks which I shall make later in the afternoon with respect to the entire program.

The PRESIDING OFFICER. Without objection, it is so ordered.

Mr. CASE of South Dakota subsequently said:

Mr. President, the Senate had before it earlier today a motion to concur in the amendments of the House of Representatives to Senate bill 86.

The amendments to S. 86 which were adopted by the House of Representatives do not alter the basic purposes of the bill as it was passed by the Senate on August 5, 1957. The amendments simply make the provisions of S. 86 a part of the National Science Foundation Act of 1950.

The bill authorizes the National Science Foundation to undertake an orderly research program in weather modification. In conducting its studies, the Foundation would consult with meteorologists and scientists in private life and with agencies of Government interested in or affected by experimental research in weather control. The Foundation is authorized to accomplish its purposes through contracts with private or public institutions, including cooperative programs with the States. The Foundation may accept as a gift, money, material, or services, and other agencies of the Government are authorized to loan property and personnel to the Foundation as may be deemed useful.

A new section of the bill, as it was amended by the House, authorizes the National Science Foundation to require by subpena information necessary to carry out its provisions.

The House also deleted a section of the bill which would abolish the Advisory Committee on Weather Control and transfer its functions, duties, and records to the National Science Foundation. That section was no longer needed. S. 86 passed the Senate in August 1957, and since that time, the Advisory Committee on Weather Control has ceased to exist.

Mr. President, for a comparatively new field, weather modification has quite an extensive legislative background. The Congress first acted favorably on weather modification legislation in 1953 when it passed the bill which created the Advisory Committee on Weather Control. That legislation—S. 285—Public Law 256—was the outgrowth of bills by the Senator from New Mexico, Mr. Anderson, the Senator from Oregon, Mr. Cordon, the Senator from Nebraska, Mr. Butler, the Senator from Washington, Mr. Magnuson, the Senator from Florida, Mr. Smathers, the Senator from New York, Mr. Lehman, the Senator from

Utah, Mr. Watkins, the Senator from Montana, Mr. Ecton, the Senator from North Dakota, Mr. Young, the Senator from Kansas, Mr. Capper, the Senator from Wyoming, Mr. O'Mahoney, and myself over a period of 3 or 4 years. Three Senate committees held joint hearings on the bills introduced at that time, and I was asked to work out a residual bill, which was S. 285.

Under that bill, the Advisory Committee on Weather Control was directed to study and evaluate public and private experiments in weather modification. The committee was comprised of the Secretaries, or their designees, of the Departments of Agriculture, Commerce, Defense, Interior, and Health, Education, and Welfare, and the Director of the National Science Foundation, or his designee.

It also included five private members appointed by the President from the fields of science, agriculture, and business. They were: Capt. Howard T. Orville, United States Navy (retired), Baltimore, Md., the chairman; A. M. Eberle, dean of agriculture, South Dakota State College, vice chairman; Lewis W. Douglas, Southern Arizona Bank and Trust Co., Tucson, Ariz.; Joseph W. George, Brigadier General, United States Air Force Reserve, Atlanta, Ga.; and Kenneth C. Spengler, executive secretary of the American Meteorological Society, Boston, Mass. The chairman and vice chairman were appointed by the President. It will be seen that the committee was comprised of outstanding men in their fields who gave their time and efforts to this work without pay.

The first executive secretary to the committee was Charles Gardner who was previously a member of my staff. Later Jack Oppenheimer was appointed to serve as executive secretary when Mr. Gardner resigned. Each of them made a real contribution to the successful functioning of the committee.

The advisory committee was not authorized to conduct basic research in weather modification, but was directed to make a complete study and evaluation of the experiments being made by public and private groups for the purpose of determining the extent to which the United States should experiment with, engage in, or regulate weather modification activities.

Mr. President, the original approach to this matter, I think, came from various points of view. The original bill which I had introduced proposed a research program through the Department of Agriculture. The Senator from Wyoming [Mr. O'MAHONEY] proposed a program of research which would have centered in the Department of Interior, as did the Senator from New Mexico [Mr. ANDERSON]. In the composite bill which we worked out it was decided it would be best initially to let the different public and private groups carry on their research and experimentation and report to the advisory committee, which should bring together the data it collected and then report to the President and the Congress. The advisory committee did so, and put out an interim report as well as a final report at the end of 1957. With that the life of the advisory committee expired. The committee made its final report to the President earlier this year.

For the RECORD, I want to say that the committee and the staff did a remarkable job. Its report is the most valuable single document in the field.

Volume 2 of the advisory committee report has a bibliography on weather research and control which is probably the most comprehensive thing of its kind ever undertaken. The bibliography itself is an important contribution.

The conclusions of the committee are also of outstanding interest. The report states that in the mountainous areas in western United States the seeding of winter-type storm clouds produced an average increase in precipitation of 10 to 15 percent with heavy odds that this increase was not the result of natural variations in the amount of rainfall.

In nonmountainous areas, the results were not as dramatic but the committee report points out that this does not mean that precipitation may not have been produced. The variability of rainfall patterns in the nonmountainous areas made it difficult to evaluate the changes that may have occurred.

I should like to read one short section from the committee report dealing with its recommendations:

> The committee recommends that a research program include work along the following lines:
>
> (1) The effects of solar disturbances on weather.
>
> (2) The factors which control our global atmospheric circulation.
>
> (3) The factors which govern the genesis and movement of large-scale storms.
>
> (4) The dynamics of cloud motions.
>
> (5) The processes of rain and snow formation, and the relative importance of the physical phenomena which govern these processes.
>
> (6) The electrification process in clouds, and the role electricity plays in meterological phenomena.
>
> (7) The natural sources of condensation and ice-forming nuclei, and their role.
>
> (8) The methods, materials, and equipment employed in weather modification.
>
> The above recommendations, all of which demand basic and fundamental investigations and research, emphasize the meagerness of our present knowledge. These recommendations also reflect the complexity of the problems that must be investigated to provide the basic scientific knowledge that is essential to a technology of weather control.
>
> Therefore, the committee recommends the enactment of S. 86, 85th Congress, which directs the National Science Foundation to initiate, coordinate, and support such a program.

Mr. President, it was a source of real satisfaction to me that after the Senate Committee on Interstate and Foreign Commerce had listened to the evidence presented in its hearings on this bill, every member of the committee who was present asked to be listed as a cosponsor of the bill as it was amended and presented to the Senate, and the bill came to the floor with 16 cosponsoring names on it, and the unanimous endorsement of the Committee on Interstate and Foreign Commerce.

Today there is a growing interest in weather modification in this country. Until enactment in 1953 of the Federal law which established the Advisory Committee on Weather Control, only a few States had passed laws in the field of weather modification. By the end of 1956, 13 States, Arizona, California, Colorado, Massachusetts, Nevada, New Hampshire, New Mexico, Oklahoma, Oregon, South Dakota, Utah, Wisconsin, and Wyoming had provided for regulation of weather modification activities in some degree. My own State of South Dakota explicitly claims sovereign rights to the moisture in the clouds and atmosphere within our State boundaries. There may be some question as to how this right might be enforced, but the indication is that our people are alert to the situation.

The United States Forest Service is carrying on a research program known as Project Skyfire to try to develop more effective means of lightning-fire suppression, including the possibility of preventing lightning fires and reducing fire danger through cloud seeding. Lightning is the greatest single cause of forest fires in Western United States.

Mr. President, water is America's No. 1 problem. Our water use has more than doubled since the turn of the century. In addition, our population has doubled. Annually we spend millions of dollars trying to discover new water sources and to better utilize those we already have, while in the sky there is a reservoir of uncounted billions of gallons of sweet, fresh, clear water. The program authorized in this bill is designed to provide the necessary experimentation program so that this generation, and those following, might eventually tap that source of supply.

We annually spend millions of dollars for drought relief in this country. We spend millions more for flood relief, and beyond that there are untold millions lost in flood and drought damage.

If clouds can be modified so that rain can be produced in time of drought, or clouds dissipated to prevent disastrous floods, the investment of a comparatively small amount of money is a wise investment. Particularly, the benefits of more accurate and longer range forecasting offer tremendous returns for efforts expended, even though we did not have the possibility of modifying the weather in any particular.

There may be a multitude of variables that create weather—it is not a thing of chance. Most of the weather phenomena seem to be conditioned by what happens at high altitudes where there are striking variations in temperature and winds with resulting currents and countercurrents. What man is seeking to do is to find the "recipe" which produces weather of different character. We look to the National Science Foundation with confidence to find the answers to our questions. Mr. President, weather is not an accident. It conditions all of life. Let us learn what we can about it.

In concluding my remarks, I again wish to acknowledge the encouragement and valuable help given by many Senators in enactment of this legislation. The distinguished majority leader, the Senator from Texas [Mr. JOHNSON], and

the distinguished minority leader, the Senator from California [Mr. KNOWLAND] not only gave the bill right-of-way on the calendar, but endorsed its passage on various occasions.

The distinguished chairman of the Senate Committee on Interstate and Foreign Commerce, the Senator from Washington [Mr. MAGNUSON], and the distinguished ranking minority member, the Senator from Ohio [Mr. BRICKER], were most helpful in their interest to see that the matter had prompt action within that committee.

The chairman of the subcommittee to which the bill was assigned, the distinguished Senator from Nevada [Mr. BIBLE], the ranking minority member, the distinguished Senator from Kansas [Mr. SCHOEPPEL], and their associates conducted full and complete hearings that were most helpful in bringing out the merits of the measure.

The hearings attracted nationwide interest from scientists and such Federal interests as Agriculture, Interior, Defense, and Commerce that have a stake in improved methods of forecasting weather and its possible modification.

Many other distinguished Senators have taken an active interest in the progress of the legislation, notably the Senator from Utah [Mr. WATKINS], the Senator from Wisconsin [Mr. WILEY], the Senator from New Mexico [Mr. ANDERSON], the Senator from Arizona [Mr. HAYDEN], the Senator from Wyoming [Mr. O'MAHONEY], and many others.

Our efforts have also received excellent cooperation from many Members of the House of Representatives, among whom I should at least mention the Honorable OREN HARRIS, chairman of the House Interstate and Foreign Commerce Committee, the Honorable GEORGE M. RHODES, who conducted the hearings in the subcommittee, my own colleague, the Honorable E. Y. BERRY, who introduced a companion bill in the House, as did Representative HULL, of Missouri, ENGLE, of California, BARING, of Nevada, and DIXON, of Utah.

To each of those whom I have named and to many others in both the House of Representatives and in the Senate who have manifested their interest at one time or another, I express my deep appreciation, along with the confident hope that our efforts in this field will bring benefits and blessings to the people of the world which can only be dimly imagined at this time.

The PRESIDING OFFICER. The question is on agreeing to the motion of the Senator from Washington [Mr. MAGNUSON] that the Senate concur in the House amendments to Senate bill 86.

The motion was agreed to.

DISTRICT OF COLUMBIA APPROPRIATIONS, 1959

Mr. PASTORE. Mr. President, I ask unanimous consent that the pending business be temporarily laid aside, and that the Senate proceed to the consideration of House bill 12948, the District of Columbia appropriation bill.

The PRESIDING OFFICER. Is there objection to the request of the Senator from Rhode Island? The Chair hears none, and it is so ordered.

The Senate proceeded to consider the bill (H. R. 12948) making appropriations for the government of the District of Columbia and other activities chargeable in whole or in part against the revenues of said District for the fiscal year ending June 30, 1959, and for other purposes, which had been reported from the Committee on Appropriations with amendments.

Mr. PASTORE. Mr. President, I ask unanimous consent that the committee amendments be agreed to en bloc; that the bill, as thus amended, be considered as original text for purposes of amendment; and that points of order shall not be waived.

The PRESIDING OFFICER. Is there objection to the request of the Senator from Rhode Island? The Chair hears none, and it is so ordered.

The amendments agreed to en bloc are as follows:

On page 2, line 3, after the word "and", to strike out "$20,000,000" and insert "$21,500,000"; on page 3, at the beginning of line 1, to strike out "$8,600,000" and insert "$5,500,000", and in line 5, after the word "the", where it occurs the second time, to strike out "following funds: highway fund, $5,500,000, and water fund, $3,100,000" and insert "highway fund."

On page 4, line 7, after the word "investigations", to strike out "$382,000" and insert "$435,000."

On page 4, at the beginning of line 22, to strike out "$4,700,000" and insert "$4,725,000."

On page 6, line 1, after the name "Columbia", to strike out "$650,000" and insert "$660,060."

At the beginning of line 5, to strike out "$39,758,000" and insert "$39,965,900."

On page 11, line 2, after the word "Rehabilitation", to strike out "$215,000" and insert "$224,800."

On page 13, line 12 after the word "Health", to strike out "$30,505,000" and insert "$30,877,954", and in line 15, after the word "exceed", to strike out "$3" and insert "$3.50."

On page 15,, line 25, after the word "committed", to strike out "$15,000,000" and insert "$15,140,000."

On page 18, line 3, after the word "license", to strike out "$2,000,000" and insert "$2,022,000."

On page 18, line 7, after the word "services", to insert "expenses of attendance of one person, without loss of pay or time, at specialized traffic engineering classes, including tuition and entrance fees;"; in line 13, after the word "vehicles", to strike out "$7,484,000" and insert "$7,907,000"; in line 14, after the word "which", to strike out "$4,670,623" and insert "$5,093,623"; and in line 18, after the word "appropriation", to insert a colon and *"Provided further,* That the Commissioners are authorized and empowered to pay the purchase price and the cost of installation of new parking meters or devices from fees collected from such new meters or devices, which fees are hereby appropriated for such purposes."

At the top of page 19, to strike out "Department of Vehicles and Traffic" and in lieu thereof, to insert "Department of Motor Vehicles"; at the beginning of line 3, to strike out "Department of Vehicles and Traffic" and insert "Department of Motor Vehicles"; in line 4, after the word "including", to strike out "expenses of attendance of one person, without loss of pay or time, at specialized traffic engineering classes, including tuition and entrance fees;"; in line 12, after the word "years", to strike out "$1,465,000" and insert "$1,042,000"; and in the same line, after the word *"Provided",* to strike out "That no part of this or any other appropriation contained in this act shall be expended for building, installing, and maintaining streetcar loading platforms and lights of any description to distinguish same, except that a permanent type of platform may be constructed from appropriations contained in this act for street improvements when plans and locations thereof are approved by the Public Utilities Commission and the Director of Vehicles and Traffic and the street railway company shall after construction maintain, mark, and light the same at its expense: *Provided further,* That the Commissioners are authorized and empowered to pay the purchase price and the cost of installation of new parking meters or devices from fees collected from such new meters or devices, which fees are hereby appropriated for such purposes: *Provided further."*

On page 27, line 2, after the words "Women's Reformatory", to insert "warehouse for public schools and Department of Buildings and Grounds (including shop facilities and record center)"; in line 5, after the words "District of Columbia Village", to insert "and motor vehicle safety inspection station (additional amount)"; at the beginning of line 17, to strike out "$15,704,000" and insert "$17,799,000"; in the same line, after the word "which", to strike out "$7,350,000" and insert "$7,850,000"; in line 19, after the numerals "1959", to insert "and $81,000 shall be payable from the highway fund", and in line 20, after the word "and", to strike out "$836,250" and insert "$862,000."

On page 33, line 2, after the word "adjustment", to insert a colon and *"Provided further,* That no part of this or any other appropriation contained in this act shall be expended for building, installing, and maintaining streetcar loading platforms and lights of any description employed to distinguish same, except that a permanent type of platform may be constructed from appropriations contained in this act for street improvements when plans and locations thereof are approved by the Public Utilities Commission and the Department of Highways and the street-railway company shall after construction maintain, mark, and light the same at its expense."

On page 36, line 10, after the word "exceed", to strike out "$25,000" and insert "$40,000."

On page 38, line 7, after the numerals "1945", to insert a colon and *"Provided,*

Public Law 85-510
85th Congress, S. 86
July 11, 1958

AN ACT

72 Stat. 353.

To amend the National Science Foundation Act of 1950, to provide for a program of study, research, and evaluation in the field of weather modification.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That subsection (a) of section 3 of the National Science Foundation Act of 1950, as amended, is amended by striking out "and" at the end of paragraph (7), by striking out the period at the end of paragraph (8) and inserting in lieu thereof a semicolon, and by adding after paragraph (8) the following new paragraph:

National Science Foundation.
Weather modification.
Research.
64 Stat. 149.
42 USC 1862.

"(9) to initiate and support a program of study, research, and evaluation in the field of weather modification, giving particular attention to areas that have experienced floods, drought, hail, lightning, fog, tornadoes, hurricanes, or other weather phenomena, and to report annually to the President and the Congress thereon."

Reports.

SEC. 2. The National Science Foundation Act of 1950, as amended, is amended by changing the designations of sections 14, 15, and 16 (and all reference to such sections in any provision of law) to 15, 16, and 17, respectively, and by inserting after section 13 the following section:

64 Stat. 154.
42 USC 1873-75.

"WEATHER MODIFICATION

"SEC. 14. (a) In carrying out the provisions of paragraph (9) of section 3 (a), the Foundation shall consult with meteorologists and scientists in private life and with agencies of Government interested in, or affected by, experimental research in the field of weather control.

"(b) Research programs to carry out the purposes of such paragraph (9), whether conducted by the Foundation or by other Government agencies or departments, may be accomplished through contracts with, or grants to, private or public institutions or agencies, including but not limited to cooperative programs with any State through such instrumentalities as may be designated by the governor of such State.

Research contracts.

"(c) For the purposes of such paragraph (9), the Foundation is authorized to accept as a gift, money, material, or services: *Provided*, That notwithstanding section 11 (f), use of any such gift, if the donor so specifies, may be restricted or limited to certain projects or areas.

Gifts.
42 USC 1870.

"(d) For the purposes of such paragraph (9), other agencies of the Government are authorized to loan to the Foundation without reimbursement, and the Foundation is authorized to accept and make use of, such property and personnel as may be deemed useful, with the approval of the Director of the Bureau of the Budget.

Loan of property, etc.

"(e) The Director of the Foundation, or any employee of the Foundation designated by him, may for the purpose of carrying out the provisions of such paragraph (9) hold such hearings and sit and act at such times and places and take such testimony as he shall deem advisable. The Director or any employee of the Foundation designated by him may administer oaths or affirmations to witnesses appearing before the Director or such employee.

Hearings.

"(f) (1) The Director of the Foundation may obtain by regulation, subpena, or otherwise such information in the form of testimony, books, records, or other writings, may require the keeping of and furnishing such reports and records, and may make such inspections of the books, records, and other writings and premises or property of any person or persons as may be deemed necessary or appropriate by him to carry out the provisions of such paragraph (9), but this authority

Documentary evidence.

shall not be exercised if adequate and authoritative data are available from any Federal agency. In case of contumacy by, or refusal to obey a subpena served upon, any person referred to in this subsection, the district court of the United States for any district in which such person is found or resides or transacts business, upon application by the Director, shall have jurisdiction to issue an order requiring such person to appear and give testimony or to appear and produce documents, or both; and any failure to obey such order of the court may be punished by such court as a contempt thereof.

"(2) The production of a person's books, records, or other documentary evidence shall not be required at any place other than the place where such person usually keeps them, if, prior to the return date specified in the regulations, subpena, or other document issued with respect thereto, such person furnishes the Foundation with a true copy of such books, records, or other documentary evidence (certified by such person under oath to be a true and correct copy) or enters into a stipulation with the Director as to the information contained in such books, records, or other documentary evidence. Witnesses shall be paid the same fees and mileage that are paid witnesses in the courts of the United States.

Violation and penalty.

"(3) Any person who willfully performs any act prohibited or willfully fails to perform any act required by the above provisions of this subsection, or any regulation issued thereunder, shall upon conviction be fined not more than $500.

"(4) Information contained in any statement, report, record, or other document furnished pursuant to this subsection shall be available for public inspection, except (A) information authorized or required by statute to be withheld and (B) information classified in accordance with law to protect the national security. The foregoing sentence shall not be interpreted to authorize or require the publication, divulging, or disclosure of any information described in section 1905 of title 18 of the United States Code, except that the Director may disclose information described in such section 1905, furnished pursuant to this subsection, whenever he determines that the withholding thereof would be contrary to the purposes of this section and section 3 (a) (9) of this Act."

62 Stat. 791.

Approved July 11, 1958.